March/April, 1972
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A Layman's Guide to Science on Apollo 16, Gene Simmons

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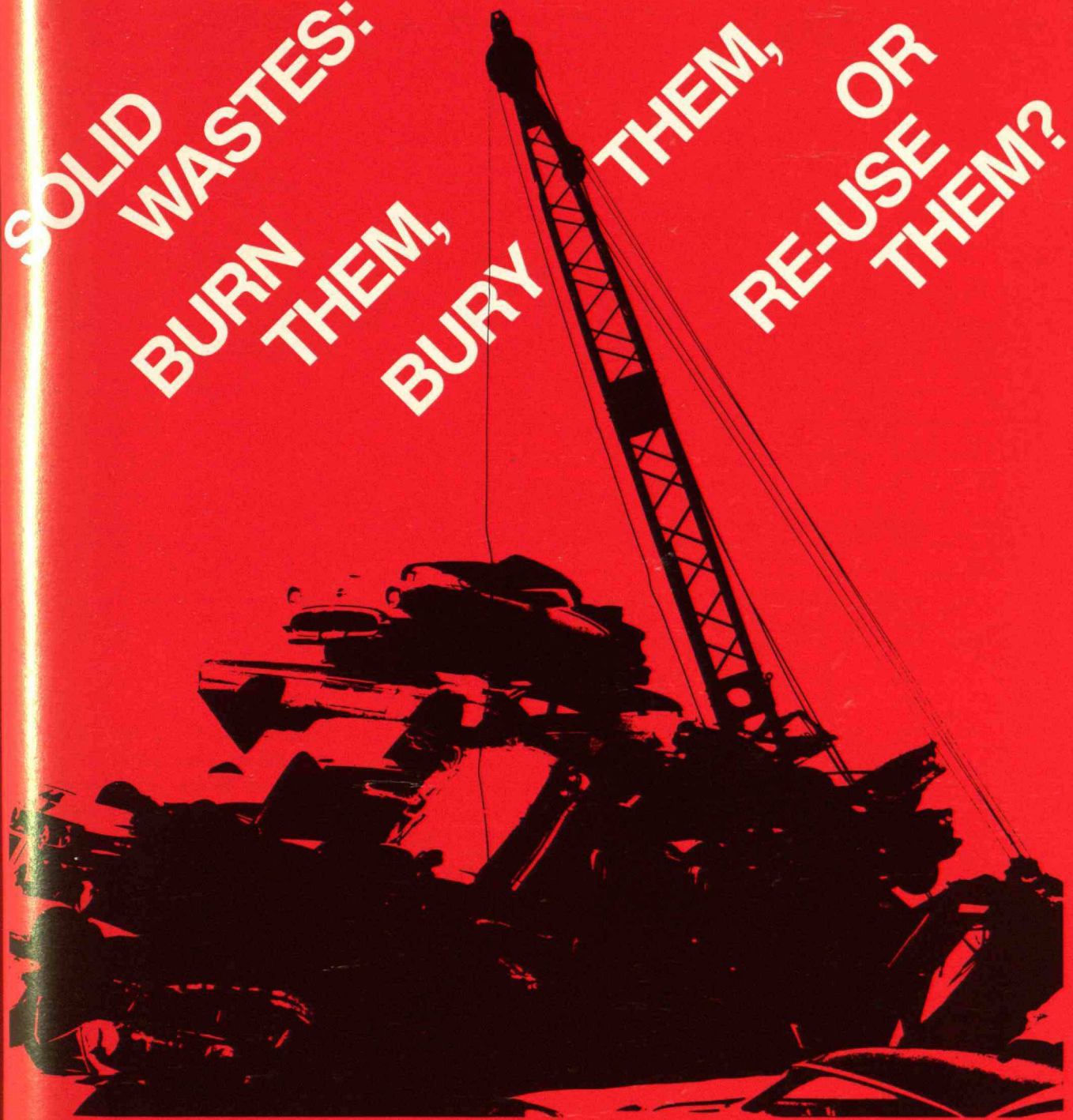
Technology Review

Edited at the
Massachusetts Institute of Technology

SOLID WASTES: BURN THEM, BURY THEM, OR RE-USE THEM?



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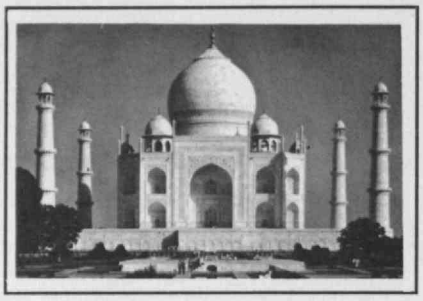

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Technology Review

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Articles

Departments

First Line

Readers and authors both know how poorly its editors are sometimes able to predict the contents of *Technology Review* even one or two months in advance. The current issue is a case in point: six weeks ago we recorded our intentions of devoting this March/April issue entirely to the problem of solid waste and the technologies for managing it. Then came Professor Gene Simmons' account of the scientific activities of Apollo 16, and the plan was changed; to accommodate this timely material, we'll spread the *Review*'s series on solid waste technology over two issues, bringing readers in May what was crowded out of the pages that follow:

Coming in May:

Solid Waste Technology II:

How to Reclaim Goods from Wastes, by David G. Wilson and Ora E. Smith, M.I.T.

Can We Recycle Cans? by Howard S. Cannon, Continental Can Co.

Biodegradation of Waste Plastics, by V. R. Srinivasan, Louisiana State University

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Short-Haul Air Transport:

Where Do S.T.O.L., V.T.O.L., and V./S.T.O.L. Really Fit? by Charles W. Harper and Hans Mark, N.A.S.A.

Technology for Short-Haul Aircraft, by Robert W. Simpson and Henry Faulkner, M.I.T.

Science for the People

An Editorial

Given that engineering is "the art and science by which the properties of matter and sources of power in nature are made useful to man," the efforts which seem to surround us to "tell engineers that society needs their skills and participation" are almost by definition redundant.

Indeed, they reduce to absurdity in the polemics of the "Science for the People" movement. Its manifesto, prepared for the 1971 meeting of the American Association for the Advancement of Science, begins with ten pages of discourse on how scientists have become the servants of an oppressive American industrial enterprise and an even more intolerable American military imperialism. The arguments are familiar: "Physicists working in optics and planetary orbits have provided knowledge which the American military was, and might still be, considering for the development of satellites in stationary orbit over Vietnam equipped with gigantic mirrors capable of reflecting the sun and illuminating large parts of the countryside at night. . . . More and more the U.S. ruling class is coming to rely openly on technological and military means of mass terrorization and repression which approach genocide . . . (and on) the ability to extract an increasingly better return on the wage investment by curtailment of . . . labor time. . . . Scientific activity in a technological society is not, and cannot be, politically neutral or value-free."

Then comes the enlightenment, in an eight-page statement of "What Is To Be Done." Here are listed six areas to which scientists should now devote themselves:

☐ Technical assistance to oppressed U.S. minorities through such mechanisms as "people's health centers," the design of "environmental poisoning detection kits," plans for open enrollment in schools, etc.

☐ Technical assistance to foreign revolutionary movements, by teaching science in such places as Cuba and North Vietnam and by other means such as those suggested above.

☐ "People's research" on day-care center operation, self-defense techniques, low-cost nutrition, and health care delivery for the poor.

☐ Exposés and investigations of the power structure by which science does in fact serve its oppressive masters.

☐ Exposition of the ideological struggle, to expose "ruling class ideology as the self-serving manipulation which it is." (Teachers are in the best position to do this.)

☐ Demystification of science and technology, to "destroy the hold of experts on decision-making."

In sum, scientific work "should both flow out of the needs and demands of the people and be relevant to their political struggles."

How different is the position of David Baltimore, Associate Professor of Biology at M.I.T., in a paper prepared for the Conference on Science in the Public Interest early in 1972. He proposes that the present size and condition of science and technology demand of scientists and their societies a new role—that of public advocate. Two examples:

☐ Decisions made daily by government and industry "require interpretation by experts for the public to understand their true dimensions." (Examples include the management of cancer research and the moratorium on biological warfare development.)

☐ There is rising in the U.S. a kind of "state science," writes Professor Baltimore. "The freedom of a scientist to make discoveries in the areas he identifies as ripe for investigation is being usurped by politicians who more and more are deciding what is legitimate science and what is mere indulgence."—*J. M.*

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Letters

Must We Kill All Our Hosts?

I want to express great concern for the implications of the article on "Geothermal—Earth's Primordial Energy" (*October/November, pp. 42-48*). We have been witness to the complete destruction of the bounty of the fertility of the soil encompassing the entire Mediterranean land area. For eight millenia human infestation has despoiled that part of the earth leaving a skeleton of the former landscape. This cradle of civilizations has sent forth hordes of humans to rape other portions of our planet.

With the passage of centuries, thanks to technological advancement, the waters of our Earth have become stinking streams and the oceans are polluted. We are in the process of destroying our air. There is little more that we, *Sapient creatures,* need do to kill our entire surface environment. Now it is proposed to sap, or if you prefer, to tap the very foundation heat source of our planet. Apparently mankind is determined to kill its host. This is the course pursued by every parasite: suck what it can 'til nothing is left!

Julian A. Joffe
Rainbow Lake, N.Y.

Energy for Food?

The problems cited by authors in your series on energy technology (*October/November, December, and January*) prompt this question: Will the price of electrical power force the frozen food industry out of business in the 1980s?

To me the question is pertinent because frozen foods require electrical energy from the time of process to the time of consumption. No other processed food is in such a predicament. All compressor-drive freezing systems require electrical energy. That electrical energy is only a form of another energy is not the question. The question is the cost of electrical energy to the 1980 user regardless of source.

G. Robert Johnson
Tigard, Ore.

Dutchman Not Lost

Lawrence M. Lidsky (*"The Quest for Fusion Power," pp. 10-21, January*) writes that only a few believers are absolutely sure of the existence of the Lost Dutchman Mine. Nuts!

A friend of mine owns the Lost Dutchman Mine. It is now in Arizona and always has been there; it was never lost.

Louis A. La Vind
Los Angeles, Calif.

On Excessive Criticism

Victor Cohn expressed an unfair and uncalled-for criticism of the new Kennedy Center in Washington *(Washington Report, December, p. 7).* True, there is criticism of the architectural treatment. But one who presumes to criticize should allow for the unusual problems so well solved by Mr. Stone—three great enterprises in one building handicapped by stringency of funds and an inadequate site. There are, moreover, many—perhaps the majority of—people who know the Center who think it dignified and graceful. And let no one forget that the acoustical properties of all three theaters are superb—certainly the primary consideration. I wish Mr. Cohn had been more generous in his article. Even the

good features he left to the end of his diatribe—as if in afterthought.
Elliott Roberts
Westmoreland Hills, Md.

On Choosing Reactors

I was disappointed to see a half-truth used in defense of his conclusions by the author of "Breeder Reactors: Some Doubts" (*Trend of Affairs, October/November, p. 76*). The half-truth to which I object is, "Some European breeder pro-

Letters continued on p. 68

Perhaps Life Was Inevitable

Science Review
Robert C. Cowen

News from the cosmos and progress in the lab are giving paleobiologists a radically new view of the origin of life.

Once they marveled that anything so complex could arise from simple chemicals. They felt only chance and infrequent change over billions of years could account for it. Now they know that they were being amazed at the inevitable.

No longer do they regard life as a statistical miracle. Even in its uniquely earthly incarnation, it seems more and more to be an expression of a fundamental characteristic of the universe. This concept of life began to unfold in the sixties and now is maturing in the seventies.

Protein-like molecules and cell-like spheres are assembling themselves in the "test tubes" of several researchers. They show that those simple precursor chemicals have an inherent potential for life-like complexity. All the information they need for the key stages of organic evolution seems encoded in the normal chemical processes.

If you have a taste for the philosophy of a biological synthesizer such as John Oro of the University of Houston, you'll sense that even the so-called "physical" universe is basically organic. What do astronomers say are the most abundant cosmic elements?, he asks. Are they not hydrogen, carbon, nitrogen, and oxygen? These are indeed the elements of organic chemistry. Add phosphorus and sulphur, he points out, and you have the essential elements for the chemistry of life.

One Comet Could Do It

Even our largely lifeless solar system should be classed as organic, Dr. Oro claims. On earth and its moon, we find mostly inorganic rock and magma. But just the methane alone on giant Jupiter has more mass than all the terrestrial planets have together. And consider the comets. Typically, one of them has at least as much organic matter as earth has today. Dr. Oro points out that it would have taken only one or two cometary encounters to have given earth a rich organic stock, even if it didn't have one to start with.

Then there are the interstellar molecules. These too have so far turned out to be preponderantly organic. Over the past two to three years, Dr. Oro notes, radio astronomers have "presented" him with virtually all the starter chemicals he would need to synthesize the amino acids, sugars, and bases from which to assemble proteins and nucleic acids, as he and others are doing in the lab. These starter chemicals are molecules such as ammonia, hydrogen cyanide, cyanoacetylene, formaldehyde, and the like.

Seen in the perspective of the organic universe, life seems predestined by the basic laws of chemistry and physics. This is the viewpoint of the builder, the synthesizer as opposed to the analyst. It's an approach to biology only now beginning to come into its own. Its practitioners seek to understand life by putting together its chemical precursors rather than by taking apart its present living forms.

Life can indeed seem incredible when you look at it from the outside in, as do the analysts. Like children befuddled by a disassembled clock, the dissectors are hard put to explain how life could arise from its components. Hence their appeal to chance or, sometimes, to a mysterious vitalizing "life principle."

The mystery vanished for Dr. Sydney Fox of the University of Miami, one of the pioneering synthesizers, as he learned to put some of the simple parts together. When you do that, he says, you begin to look at life from the inside out. You begin to see how simple chemicals can organize themselves in unsuspected ways.

It Was Enough Information Then

Dr. Fox works with amino acids, both those now found in protein and others. As with other researchers in this field, he may simulate primitive conditions by using the kinds of amino acids likely to have formed in earth's early history. Energize mixtures of formaldehyde, ammonia, and other probable constituents of the primordial atmosphere, using, say, a spark to simulate lightning, and these amino acid mixes result.

Heat such a mix under dry or semi-dry conditions, and the amino groups form long polymers that Dr. Fox calls proteinoids. They are like contemporary proteins except they may not have all the usual protein-forming amino groups and may include others not found in proteins today.

Place the proteinoids in hot water, and they form microspheres reminiscent of living cells. They have semi-permeable membranes that pass small molecules while holding back larger ones. Like cells, they have a characteristic limit to their size. Instead of growing beyond a certain volume, they divide in two. Sometimes, like some bacteria, they may bud off new spheres which, in turn, grow to "maturity."

Small enough to move with Brownian motion, the spheres may bump together and link up through hollow tubular collars. Tiny particles inside them can pass from one sphere to another through such collars. These "endoparticles" could themselves probably grow into full-sized spheres, although at this writing Dr. Fox and his associates had not yet tested this. Under some conditions, a sphere containing many endoparticles will burst to scatter its contents in a manner akin to spore dispersal by some plants today. These dispersed particles have been "bred" through three generations of microspheres.

The proteinoids show intriguing biochemical activities. Duane L. Rohlfing, of the University of South Carolina, points out that they have some enzyme action. Also, he notes that they do not form at random from the amino-acid mixtures. They have preferred structures. There seems a degree of self-orientation in their self-assembly.

In their reproducibility and selective chemical interactions, Dr. Rohlfing sees properties he defines as "informational." Such informational properties and the protein-like structure of the proteinoids suggest to him that prebiotic events occurred with order and direction. This could have happened even in the absence of nucleic acids which carry the genetic information today.

Proteinoids and the microspheres don't look much like contemporary cells and their specialized proteins. However, Dr. Fox warns that, whatever the first cells and proteins were like, you can't expect them to have been like their modern descendants. "My basic tenet," he says, "is that the contemporary didn't evolve from the contemporary."

He thinks modern proteins, for example, are far too specialized to be starting material for evolution. Primordial cells and proteins would have been simple with a general potential to evolve in many directions. Dr. Fox thinks the microspheres and proteinoids suggest this kind of simplicity. He makes no claim that primitive life was like these. But their ability to self-assemble suggests a model for the evolution of that life.

Dr. Fox also sees a model for primitive information transfer between generations in the movement and reproduction of the endoparticles. Without wanting to push inference too far at this stage, he tentatively suggests that the first organisms could have gotten along quite well with this kind of information-carrying system only. The more sophisticated D.N.A.-R.N.A. nucleotide systems could have evolved later.

As a model for the rise of life, Dr. Rohlfing explains that the proteinoid-microsphere system has geophysical plausibility as well as biological simplicity. The amino acids form from their precursors at temperatures typically around 1,000°C. They link up into proteinoids at say 170°. Then the proteinoids form microspheres in water at about 100°. Certainly, Dr. Rohlfing says, such temperatures are well within the geophysical range. The reactions themselves could take place within geographically restricted regions—hot springs or around volcanoes.

Life as Probable

Here then is a geophysically and biologically plausible model of how the protoproteins and protocells could have arisen. It answers what Dr. Fox calls

key chicken-and-egg questions. How did cells arise without pre-existing cells to make them? How did proteins and enzymes appear without pre-existing patterns and pre-existing enzymes to catalyze their preparation?

Order, answers Dr. Fox, didn't arise out of chaos. It arose out of pre-existing order. Amino acids contain all the information needed to form proteinoids and probably to form true protoproteins. These in turn have all the information needed to form microspheres and probably protocells. Dr. Fox and other researchers in this field consider the principle of self-assembly to be perhaps the most important conclusion so far to arise from their work.

Indeed, a version of this may also explain the rise of the nucleic acids. As John Oro points—out, all the sugars and bases needed to assemble a nucleic acid can be made from primordial chemicals by geophysically plausible paths. Given these sugars and bases, he thinks the nucleic acids should arise virtually spontaneously. With the help of one of the "primordial" chemicals, cyanamide, his laboratory has been synthesizing polynucleotides which seem to bear the same relation to nucleic acids as do proteinoids to proteins. There is some capacity within these molecules to organize themselves, Dr. Oro says. His laboratory, at this writing, was in the process of growing what he said may be virus-like molecular chains.

Biologists never were comfortable with the notion of life as improbable. It implies an unwelcome degree of uniqueness in a phenomenon they feel ought to be universal. Now, it seems, the synthetic approach to biology and its principle of self-assembly promises the universality for which they have longed.

With sophistication and awesome detail, analytical biology has explored the machinery of life on earth. Yet, in a fundamental sense, the science of life has been in its infancy. It has been playing about with the mechanisms of a single planetary sample. Now biology is entering an era in which it promises to mature through discovery of underlying principles which will show life on earth to be but one manifestation of a universal cosmochemistry.

How Technology Reaches Us

Washington Report
Victor Cohn

"Man has created a technology that distorts his humanity . . ."

"Technology is all honest men's enemy . . ."

These are the charges today against science and technology. But there is at least a little more effort in Washington recently to accommodate humanity.

Enough effort? Radical enough effort? These questions need answers area by

area, but the general answer is, "No, not enough, not deep enough."

This probably applies to the President's "New Technological Opportunities," his pledge to use the expertise that penetrated space to reshape America. But—I write in late February— it is a bit early for my taste to give even a tentative grade to this Nixon effort. Perhaps next month one can sensibly say more.

Beyond this, the Administration and Congress and legislatures and city councils apply technology every day in dozens of other areas that are usually seen as pure politics. It is a continuing thesis of this column that all of us interested in the uses of science and engineering ought to watch these.

For example, far too few persons, mainly officials and businessmen, are grappling with the future uses of that great technological teaching machine of our time, the magic eye, the rube tube, the Box, the medium with the message that the average American is under-arm dry and artificially beautiful. Television.

Limiting Campaign Spending

Congress and the White House have just joined in one step forward in preventing the misuse of this medium: a limit on campaign spending for time on the compelling tube. I give Congress first credit because the White House tried to stave off or whittle down any meaningful reform. By and large, the Democratic leadership in Congress put it over, with enthusiastic help from some Republicans, less from others.

The difference between the parties was no measure of their good or evil. The Republicans are far better off in campaign funds and prospects for more as 1972 unrolls. Campaigners don't willingly toss away weapons to make things equal.

In fact (wrote Rowland Evans and Robert Novak) "chief White House lobbyist Clark MacGregor prowled the Republican cloakroom with this private message: There would be no great unhappiness by President Nixon if Congress did not pass any campaign spending reform bill at all."

The President had already vetoed a 1970 bill to restrict T.V.-radio spending; last year he accepted a provision for a voluntary $1 future income tax checkoff for the party of your choice only on condition that it take effect no earlier than 1976, which means a future Congress might repeal it.

The huge strain of money-raising on all members of Congress overwhelmed the President's reluctance on the new T.V. reform. When all was said and done, both houses overwhelmingly adopted a new law that says: candidates for President or Congress may spend no more than 10 cents per voting-age person on all communication media (subject to cost of living increases). No more than 60 per cent may be spent on T.V. and radio.

The effect will be to limit presidential candidates this year to no more than $8.4 million each on T.V.-radio after the conventions. There will still be other ways candidates can out-spend each other—on newly sophisticated, computer-assisted electorate breakdowns and appeals, for one.

Still, the new law if it works could prove quite an equalizer. In 1968 the Republicans spent $12.6 million on T.V.-radio for Mr. Nixon versus the Democrats' $8.1 million for Humphrey. The $58.7 million spent on all political broadcasts in 1968 was up 70 per cent from 1964. In seven big-state 1970 Senate races, 11 of the 15 major candidates were millionaires. All four non-millionaires lost.

As the Indian chief said, however, there is some good news and some bad about electoral television.* There will still be those slick T.V. spots, the 10-second-and-up blurbs which portray our candidate as the Man from Glad and his opponent as Mr. Ugly, the purveyor, it is suggested but not really stated, of war, poverty, and pestilence.

John O'Toole, president of Foote, Cone & Belding, has urged "all of us in the advertising business not to be beguiled into making" commercials that "confuse a candidate and an office with a deodorant and an armpit." O'Toole urges a five-minute minimum length on political messages to discourage this "shallowest kind of imagery." I think we could all vote for this five-minute limit, but how Lincoln and Douglas still would shudder at it.

Supporting Intelligent T.V.

Beyond party politics, the country is paying little attention to the tube's far more important role in humanizing or dehumanizing us: its mere daily barrage.

No one can make much of a brief for the present overwhelming T.V. diet of pap and late yap except to say that we all like it sometimes. But we all like other things, too. Solid documentary is rarer and blander than it was 20 years ago (and then only an Edward R. Murrow rarely dared be unbland). Good drama is rarer than it was in those modestly golden years. The pap audience rules.

Many of us have hoped that Public Broadcasting would become the alternative network. Public broadcasters can assemble an audience for only so many low-budget talk shows, however. The average local or national public T.V. show is still technically weak for lack of production money and is therefore no pleasure to watch.

Congress is now, after years of urging, giving public broadcasting a $35 million annual appropriation. But even this puny subsidy is raising large questions about the possible independence and strength of any system which must depend on it. Both the White House and several Congressmen have fumed because the Public Broadcasting System has hired some supposedly liberal-leaning, not to mention expensive, political reporters.

Clay T. Whitehead, the administration's director of telecommunications policy, has charged that the very establishment of a national news show on public T.V. is contrary to the spirit of the constrictive legislation that created the Corporation for Public Broadcasting. He says the Public Broadcasting Act of 1967 intended primary emphasis on *local* programs—much safer politically—and that "we have witnessed the development of precisely that which the Congress sought to avoid, a 'fourth network' patterned after the B.B.C."

We have in fact *not* witnessed the development of anything like a strong fourth network or B.B.C., because if we had we would be able to tune in on regular commentary of many political stripes. On private and public T.V. we instead see mainly timidity: carefully weighed words instead of sharp opinions on the hundreds of subjects which in our time cry for sharp opinions.

On February 11, for example, P.B.S. General Manager Gerald Slater announced that his unfearless network was dropping plans to show "The Politics and Humor of Woody Allen," a political satire aimed at the Nixon Government. The program was produced by Channel 13 (WNET), the P.B.S. station in New York City. Jay Iselin, its general manager, said he intended to show it anyway. He said, "It appears we've managed to produce a mouse that might scare the President."

In a T.V. system beholden to Congress for funds, mice will always rule. The B.B.C. lives not on an annual appropriation but on licensing fees on T.V. and radio sets. Couldn't we agree on some such form of financing for a network that casts equal light and satire on all parties? They are in equal need.

And Writing New Rules for Cable

In the next few years we are about to see a vast expansion of a whole new system of T.V.: cable television. Cable will bring into your T.V. set, for a fee of $5 or $6 a month, a very large number of channels—the number is theoretically almost unlimited; the actual number will depend on the initial investment.

In the best of possible worlds, this technological advance could make available several public and educational channels to carry politicking, drama, music, ballet, opera, education for the young and adults and as many special-interest telecasts as any one can imagine or pay for—at a cost that will be far lower than today's over-the-air signal.

In practical fact, commercial cable operators, by a new set of Federal Communication Commission rules, must pledge only that they will make available one free channel for educational television, one for "first come, first served" public access programming and one for local government, although (in the top 100 markets) they will provide at least 20 and in some cases 40 channels, mainly carrying the offerings of local and out-of-town commercial stations.

The new F.C.C. regulations were designed to end a long freeze on cable T.V. expansion. The fight that caused the freeze had nothing to do with the availability of public channels or funds for public programs. It had to do with how many out-of-town commercial programs a cable operator might offer to compete with local T.V. broadcasters.

Here, the locals mainly won, prompting one young federal telecommunications official to explode, "I'm a Republican,

* The tribe is traveling over mountains by winter and starving, and the chief says: ". . . First the bad news. We have nothing left to eat but snow. Now the good. There's plenty of snow."

but I can't see why the hell we should be protecting a very rich set of station owners from new technology."

The whole cable T.V. question has been discussed mainly in the dark between commercial broadcasting interests and federal telecommunications and F.C.C. officials. Yet cable is *the* near-future national communications system. Only a very few communities—Arlington, Va., is one—have active citizens' groups trying to persuade local political bodies not to grant cable franchises until there is assurance that the system will be strongly available for public participation, beyond a few token channels. Arlington in fact has a progressive cable T.V. ordinance requiring that Arlington's future cable operator allocate *eight* channels for public uses.

I believe that maverick F.C.C. Commissioner Nicholas Johnson rightly sees the less progressive new F.C.C. cable rules as a blatant example "of industry domination of government." The key decisions have been made in private discussion with commercial broadcasters, with little open debate or expression from the minorities, the poor, educators and everyone who might be able to scrape together a little money to put a program on the newly-wired Magic Tube.

Science Fiction: Will Robots Marry?

Special Report
David B. Searls (M.I.T. '73)

What does one do at a World Science Fiction Convention (for instance, the one that met in Boston last fall)? If one is interested in the theory and practice of science fiction in general, one can attend the lectures, panels, and dialogues that are offered in profusion. One can show up at the midnight-to-dawn film program, and see anything from *2001* to *It Came from Beneath the Sea.* If one wants to assume the form of his favorite extraterrestrial being from half a century of science fiction, one can attend the Masquerade and Costume Competition, and appear on everything from the pages of the New York Times to the whimsical wrap-up spot on the late news. If one is bored by it all, one can inebriate oneself at the convenient hotel bar.

If one is interested in the practice of science fiction in the concrete, one can commune with masters. Isaac Asimov, for example, the acknowledged dean of SciFi writers. Known throughout Fandom as "the Good Doctor," he is the author of over a hundred books on science, mathematics, medicine, Shakespeare, and even the Bible—in addition to his hefty output of hard-core science fiction. The non-fiction works take the form of comprehensive surveys (Asimov's Guide to . . .) of the field. (They would probably make good correspondence courses, as fans often say.)

Like a latter-day sophist, his appearances draw his own personal fandom in flocks where, even in auditoriums, they give the impression of sitting at his feet. While his jokes draw enthusiastic laughter, his witticisms incur waves of murmurous admiration that create a positively eerie effect.

Cliff Simak is the perfect foil to Asimov's effusive wit. A grandfatherly figure, Simak has been a writer of repute since nearly the very beginning of science fiction (as we know it). As guest of honor of the convention, he and Asimov served together on a panel somewhat ambitiously entitled "The Robot's Place in Society." They spent the first twenty minutes engrossed in mutual praise.

When they proceeded to the point at hand, it was clear that it was all Asimov's show. While the format was to take turns speaking, Simak's talks were for the most part embarrassingly short and not too profound, while Asimov's were speculative, ingratiating, and anecdotal.

We Will Build A Robot . . .

Their supposedly logical and objective derivation of the consequences of automata underwent great leaps of faith—the discussion quickly advanced along precisely the lines delineated by 40 years of science fiction, without consideration of less exciting eventualities. Perhaps this was dictated by the mood of the audience, who would surely have been impatient with scientific rigor. But, it was distressing at times, to witness these quantum jumps of imaginary technology; at one point, for instance, Simak decided that he thought that any robots to be developed in the future "must look like man, and must have emotional ties." Asimov, perhaps himself taken slightly aback at this, at least rationalized it a bit, by resorting to some impromptu psychology: he theorized that man would anthropomorphize robots because he "likes to give machines human proportions." Simak promptly affirmed this by confessing that he had given a human name to every single automobile he had ever owned.

One wonders if there is not a yearning among SciFi writers to "escape from freedom" and at least partially renege on their vast privilege of imagination. There is evidence of this in Asimov's three robotic rules—a set of regulations for the behavior of future automata which have become standard for not only him but for many other writers.

But what redeems Asimov through adulation, standardization, and oversimplification is the suspicion that his tongue is in his cheek throughout: in discussing robotic morality, he makes the pronouncement that "in this modern age of enlightenment, marriages between humans and androids are perfectly all right." There are other, occasional glimmerings of reservations in his manner, as if the science were gaining temporary dominance over the fiction. He and Dr. Simak threw the floor open to questions or comments, and a short, energetic man of white beard stood up impatiently.

The gentleman was Lester del Rey, another noted writer of the old guard who launched upon a long, involved, frenetic exposition on the state of the robotic

art: "We will build a robot to build a better robot when the economic necessity is felt, because after all, necessity is not the mother of invention; it is economic necessity. And that will come with space exploration, when we come to realize that robots can do jobs that it is impossible for men to perform."

But the Brain Is Too Big . . .

Del Rey continued by describing in detail how robots would be superior to men in the extremes on the various planets. Then, replying to a point made by Asimov on the size of the robotic brain that would be necessary to equal the capacity of man's, he disjointedly discoursed on computer science and electronics in general, and ended syllogistically: since the ratio of masses between transistor equipment and integrated circuit equipment is on the order of 10,000 to 1, and since there is no reason for us to expect the boys in research to slow down the pace, it is perfectly valid for us to expect another 10,000 to 1 reduction before long, which is about the size we'd need for a robot's brain to equal a human's.

Del Rey finally stated: "Isaac, we'll have robots," and sat down.

There was a mild but tangible shudder of excitement in the crowd at these optimistic and inspirational words. The reason Lester del Rey knows so much about robotics, explained Isaac Asimov, is that he's been writing robot stories for a long time—almost from the beginning.

. . . Isn't It?

In the program for the day after the Asimov-Simak-del Rey affair was the modest entry "Artificial Intelligence talk." This turned out to be a lecture-demonstration by M.I.T.'s and Project M.A.C.'s own Seymour Papert.

Papert began with a low-key investigation, asserting that "nobody really believes truly in his heart of hearts that machines can have intelligence"—a comment which doubtless caused a little soul-searching among those present. But he went on to say that mankind will eventually have to choose between allegiance to the flesh and allegiance to the mind, since the development of automata could be seen as advancing the evolutionary process in terms of the latter.

Still, his typically scientific reservations were positively Cartesian in comparison with del Rey's optimism. "We cannot be sure of anything," he said. "We're embarking on something so different from anything we've done before that predictions just aren't possible. . . . In his science fiction, that great man, Isaac Asimov, showed that you cannot see the consequences of automata in advance."

It was here that Papert seemed moved to pay some tribute to science's being transcendentalist rather than mechanistic. These two views, he said, have represented relatively distinct approaches to the problem of artificial intelligence. He also contended that the mechanists were following a dead-end path—they held too simple a concept of machines, a concept that systematically distorted the idea of knowledge. He used as an example the problem of translating Russian—early attempts were busts, Papert said, because the programming was not designed for understanding of what was being translated. More recent projects in the problem of language comprehension were incorporating the concept of microworlds—small areas of real understanding that make knowledge functional. Conceivably, these micro-worlds could be juxtaposed, cascaded, or otherwise manipulated to create a real form of knowledge.

Papert's main point was that "all knowledge is artificial"—not a matter of the number of neurons or logical construction, but rather dependent upon its organization and patterns of assimilation. One of the science fiction fans, who might perhaps have had in mind the previous day's dialogue between Asimov and Simak and Lester del Rey's monologue, asked the obvious question: does this mean, then, that the key to knowledge is in the program and not in the hardware? "Absolutely," replied Professor Papert. But even this was not the most obvious difference between the two presentations. The most obvious difference was the fact that, while the science fiction writers packed the auditorium, it was a relative handful who stirred themselves to see the real thing.

But What Is an A.B.M. System?

European Report
Rex Malik

If you look at the history of success and failure in disarmament talks, two things immediately stand out. One, agreement is much easier to obtain when the subject matter under discussion is concerned with future events on which military establishments have not yet built themselves into positions from which it is difficult to withdraw and on which—preferably—even contingency planning has not yet taken place. Two, the more politically unpredictable the result of not coming to an agreement, the easier it is to agree.

International agreement in the disarmament area, then, becomes more and more possible the further away you move from areas in which politicians have prepared positions to fall back on. This means that the matters on which agreements are sought are usually so complex that few people really understand what they are all about.

It is in this light that one needs to look at the continuing Strategic Arms Limitation Talks, the series of American-Russian conferences which have ambulated between Helsinki and Vienna since November, 1969. Since the summer of last year, the experts have been trying to work out an agreement for the limitation of the deployment of anti-ballistic-missile systems. They have "also agreed to seek for agreement on certain measures with respect to the limitation of offensive weapon systems." The phrase is taken from a joint Washington-Moscow statement, and you would need a team of experts to tell you what it means.

The problems are in part semantic—in this case, however, somewhat important semantics. There is the political semantic problem. Thus the "Treaty on the Prohibition of Emplacement of Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof," to give it its full title—the agreement reached immediately prior to these talks itself—gives defense planners some problems, if words are to mean roughly what they are supposed to mean. In the United States, the problem is caused by SAMBIS, a U.S. Navy proposal to develop Poseidon for use in a submarine-carried A.B.M. system. The agreement, however, forbids emplacement on the sea bed. So when is emplacement not emplacement? When the weapon is mobile and carried? An A.B.M. weapon, of course, leads us down the road of anti-A.B.M.'s, with effects on the oceans probably the same as those the treaty tries to prevent. It is a situation which would have delighted Lewis Carroll.

There is also the defense-system semantic problem. What is an A.B.M. system? The question is nowhere nearly as stupid as might at first seem. Indeed, the question lies at the core of the discussions. The problem is caused by the lavishness with which the U.S. and U.S.S.R. have equipped their defense establishments over the last 20 years.

In any general discussion of defense systems, it is normally accepted that each class of weapon systems is unique—that it can be used to do only what its planners expect of it. However, administrative convenience and technical reality are often worlds apart, and they are in this case.

A.B.M. systems consist of: weapons, currently some sort of missile; weapons complexes to house them; radars—isolated and/or grouped; communications networks which are also used for control of response; and ground evaluation and control systems, usually computer-based, which will be used to trigger off the response. But these are the basic elements of almost any kind of land-housed missile system; these are the elements, too, which will trigger off a naval response.

Can these be used in an A.B.M. role? The answer is yes. It should be possible to patch together part of existing systems to play such a role and, what is more, to do so without leaving many tell-tale traces. But if someone does this, then the rationale underlying any A.B.M. limitation agreement is seriously stretched. And this, say the experts, is one of the major problems that the talks have been about. It is not exactly the headline grabber of the year; it is a little too complex and technical for that.

It is, I suspect, going to be a long time before any big dramatic agreement is possible. But limitation? Of course; certainly in time for the Presidential election in November. Or is that being too cynical?

Walter R. Niessen
Manager, Environmental Systems Group
Bolt, Beranek and Newman, Inc.

What We Do with Rubbish

Urban solid waste becomes a larger problem each year. We ask, therefore, with increasing urgency about our ways of handling it, how to improve them, what resources we can recover, and what markets may exist for reclaimed materials and processed refuse. We are beginning to ask (perhaps not wishing to hear the answer), do we need the convenience, the abundance, and the pizazz of a superpackage, planned obsolescence, or products used only once?

Although the rural areas in the United States do contribute to the national problem, the low total population and small amount of refuse generated per square mile present few serious problems. The little incentive for advanced waste collection and treatment methods arises when population and waste generation are highly concentrated. Our concern here is therefore with urban wastes of the sort normally delivered to a city dump, incinerator, reclamation plant, or composting unit. (This excludes agricultural wastes, specialized urban materials such as industrial wastes and automobiles and large quantities of bulky wastes, such as demolition and construction trash and household appliances.)

Glass	Bottles (primarily)
Metal	Cans, wire, and foil
Paper	Various types, some with fillers
Plastics	Polyvinyl chloride, polyethylene, styrene, etc. as found in packaging, housewares, furniture, toys and non-woven synthetics
Leather and rubber	Shoes, tires, toys, etc.
Textiles	Cellulose, protein, and woven synthetics
Wood	Packaging, furniture, logs, twigs
Food wastes	Garbage
Yard wastes	Grass, brush, shrub trimmings
Miscellaneous	Inorganic ash, stones, dust

The variety of materials that fall into the ten basic categories of urban trash can be seen above. Not only does each category offer particular problems in disposal, but often each separate material offers its own—some of the plastics, for example.

What We Have . . .

If we are to dispose of trash in more productive ways, we must understand what it comprises. Urban trash of the kind described in the previous paragraph falls into the ten basic categories shown in the chart at the top of this page. Though all of these categories are represented in most municipal waste, wide variations in the composition of urban refuse exist across the U.S., the result of variables such as industrial mix in the community, regulations on open burning, and weather and climate.

The amounts of each type of waste that arrive at typical processing plants throughout the U.S. have been the subject of a number of studies, and the average results are shown opposite. Paper and food-wastes are universally the largest components, as are yard-wastes during the growing season, and only the "yard-wastes" and "miscellaneous" categories vary much from season to season or region to region.

. . . and What We Expect

Several significant changes in the composition of solid waste can be projected for the future on the basis of growth patterns in U.S. population and consumer goods markets. These are shown in the charts on the opposite page and may be summarized as follows:

☐ In the composition of refuse:

Glass—the fraction of glass in refuse appears unlikely to change significantly over the next thirty years, unless low-cost beverage and food-grade plastic containers are developed. That development, however, would have a considerable impact.

Metal—The metal content of refuse will drop slightly, although the amounts may increase a bit in a given community. The economics of metal recovery operations, therefore, should vary only slightly. The steel industry has recently expressed a willingness to accept unincinerated ferrous scrap from refuse sources at prices near $15 per ton. Research—which seems promising—is underway on the acceptability of incinerated metal.

Paper—Continuing their historical upward trend, paper, cardboard,

Walter R. Niessen joined Bolt Beranek and Newman Inc. only a few months ago; he had previously worked for several years for the Air Force and then for Arthur D. Little, Inc., on a number of projects in environmental management and applied combustion technology, including a study for the Environmental Protection Agency on the problems of air pollution associated with municipal incinerators. He received both S.B. and S.M. degrees in chemical engineering from M.I.T.

The technology we have applied to disposing of solid wastes is primitive—yet the quantity to be disposed of will be three times as large in 30 years.

and other wood-fiber products will comprise the dominant fraction of urban refuse in 2000. This growth, 30-35 per cent, will decrease the refuse density, adversely affecting almost all refuse collection, storage, and handling operations. The increase may favorably affect the economics of waste paper recovery. Reusing paper should be increasingly important as the further growth of our pulp resources becomes difficult in the late 1980s.

Plastics—The almost 400 per cent growth in discarded plastics indicates that operating problems associated with the burning of this waste component can be expected to increase.

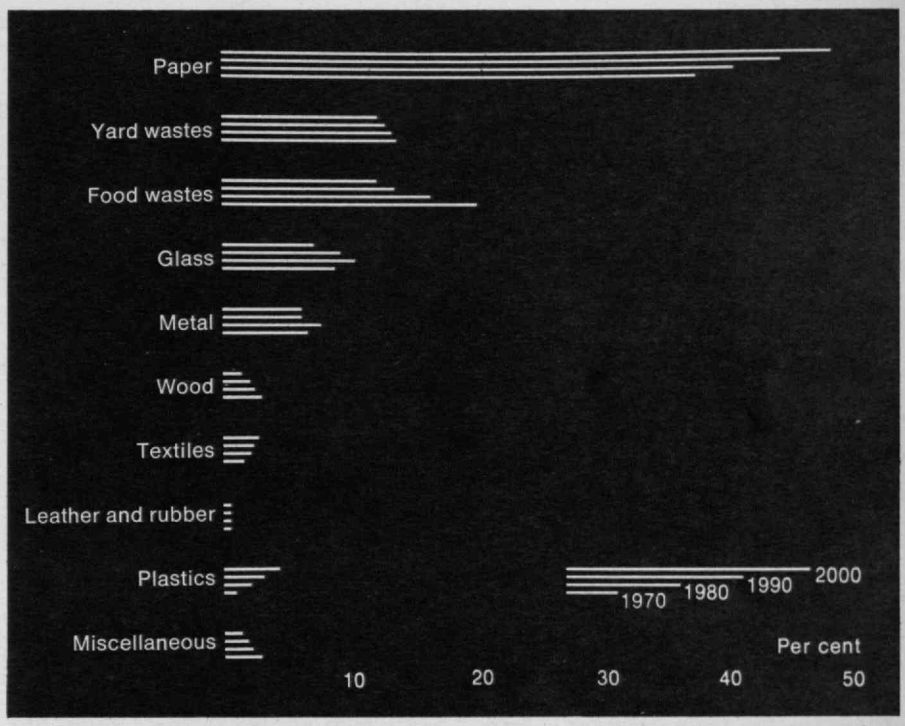
☐ In how rubbish will burn:

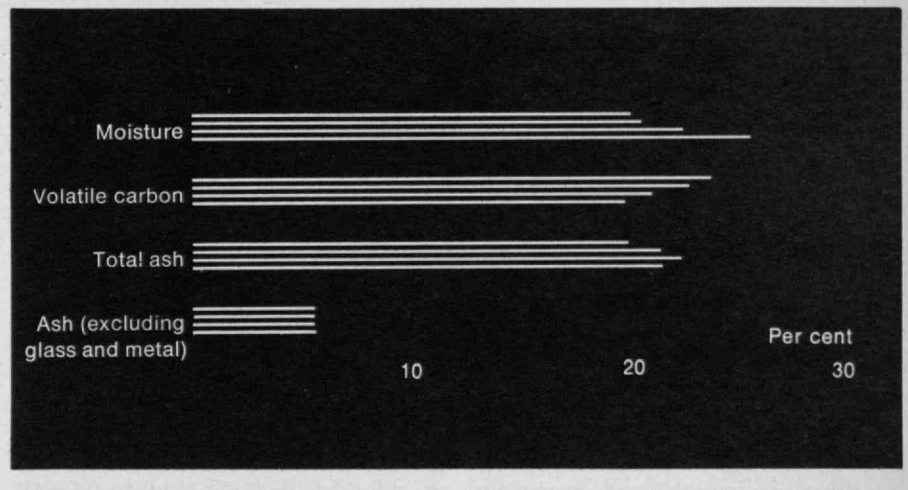
The changing composition of trash foreseen for the next three decades will result in changes in the physical and chemical properties of urban refuse:

Heating value—The heating value (B.t.u./lb.) of municipal refuse can be expected to increase at a low but regular rate for the next 30 years. Since an incinerator is, in effect, a heat disposal system, the increase in heating value can be expected to produce a roughly corresponding decrease in the capacity of furnaces. Thus a unit designed for a peak of 250 tons per day in 1968 may have a usable capacity of only 215 tons per day by 2000.

Moisture—The indicated drop in average refuse moisture—from a decrease in food and yard wastes—should cause flue gas temperatures to increase, further decreasing effective incinerator capacity. This parameter is greatly influenced, however, by refuse storage practices and local weather conditions.

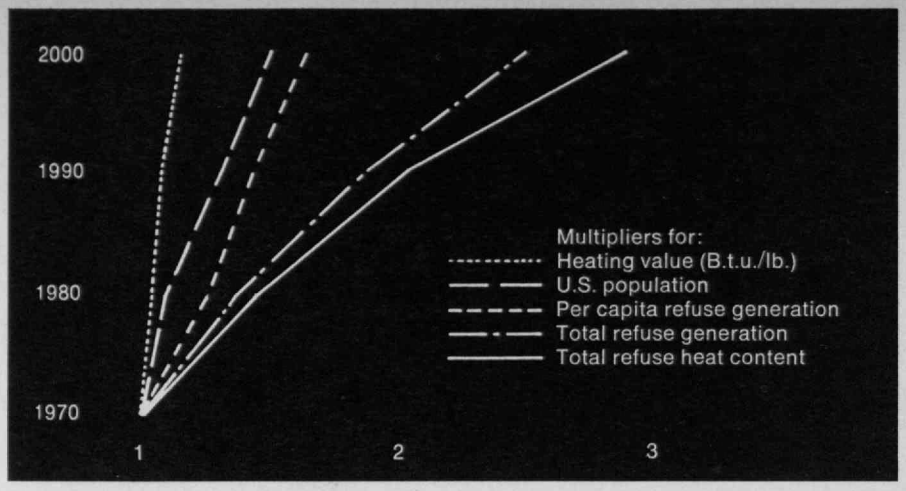
Volatile carbon—The volatile carbon content of refuse affects the





The percentages (by weight as discarded) of paper, glass, metal, and other components to be found in urban waste in 1970 are shown in the chart above (the bottom bars in each case) with projections for 1980, 1990, and 2000 (top bars). We will discard increasingly large amounts of paper and plastics and increasingly smaller ones of yard and food wastes. The chart below shows the changes in the same four years (in percentages by weight as burned) that are predicted in the content of moisture, carbon, and ash.

The changes in refuse composition will increase its heating value as this chart shows; the waste discarded per capita will also increase, as will the number of people discarding it. All those factors added together means a more than three-fold increase in the heat to be disposed of from incineration. The changes are expressed in ratios to the data for 1970 as the base year.



fraction of combustion taking place above the burning bed in an incinerator and the rate of formation of soot. The slow but steady increase in this parameter (19 per cent over the next 30 years) will make more important the attainment of satisfactory overfire air mixing and flue gas residence time prior to quenching. A design that ignores this will produce more combustible particulates, carbon monoxide, and hydrocarbons in the effluent flue gas than incinerators do now.

Ash content—Our projections show an increase, then a decrease, in total refuse ash content. This parameter could be important as it affects residue disposal, but the effects will be small.

The effects of these changes will be compounded by the increase in the total collected household and commercial refuse projected for the next three decades in the U.S.—from 100 million tons this year to 270 million by the year 2000.

This, in a nutshell, is the scenario with which waste management is now confronted. None of these projections, of course, take into account what might happen were recycling practiced with serious intent.

What We Have to Work With . . .

The technology of solid waste management falls into three segments: concentration processes, treatment and separation processes, and ultimate disposal processes. Concentration, including on-site storage and handling, collection, and transport, is by far the most costly. It uses modern technology least, and it is highly labor-intensive; how—and how quickly—this situation may change is the subject of an article in this series next month by Professor David G. Wilson. Treatment processes, including, compaction, incineration, shredding, reclamation, and composting, today represent the most intensive use of technology; these processes typically represent about one-third of the total cost associated with waste management, and they tend to have the greatest public visibility. Disposal processes, including landfill and ocean dumping, range in technological sophistication from very low (open, burning dumps) to moderate (sanitary landfill). They tend towards capital-intensiveness and also are quite visible to the public.

. . . for Collecting and Compacting

Collection of waste from its many places of generation—the first problem in disposal—is characterized by considerable manual handling; it is viewed by most workers as a disagreeable and low-prestige occupation. Collection now costs typically from $8 to $20 per ton—often more than 50 per cent of the total waste management expense.

The equipment used to concentrate and transport commercial and domestic refuse has changed little in the past 30 years. We rely chiefly on small containers manually dumped into collection trucks. Hydraulic compaction on these vehicles has increased their peak load, making fewer trips necessary, and diminished the litter falling out as they move through the streets. Compaction levels, however, are seldom greater than 3 to 1, and the capacity of refuse collection vehicles is still limited less by weight than by volume.

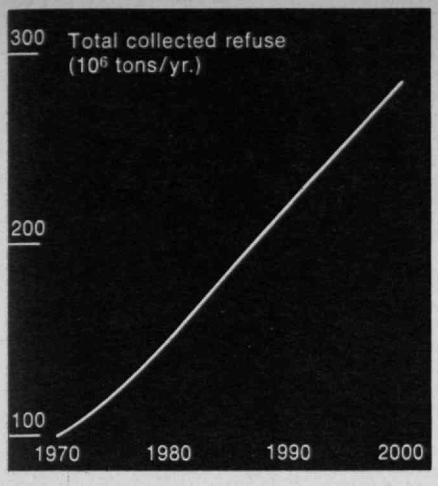
These low levels of compaction suggest that the volume of much of the bulky refuse will not be markedly diminished in the collection process. Materials such as rigid plastic containers will thus contribute to collection cost to a greater extent than suggested by their small contribution in weight. Indeed, as the numbers of plastic containers and other bulky items in refuse have increased and the amount of food wastes (which help to wet and consolidate paper waste) has decreased, a decline in refuse density has already been observed; those who handle the material generally agree that refuse is substantially less dense now than it was ten years ago. This trend will continue.

Increasingly, the packer truck is giving way to containerization of refuse at commercial and industrial sites, which has the advantage of reduced manual handling. In some cases, containers are equipped with hydraulic compactors which compact rubbish about as well as the packer truck, and efficiency is marginally increased.

. . . and for Concentrating and Reclaiming

After trash is collected, several processes are available to recover useful materials from it or to make it easier to dispose of: more compaction, incineration, shredding, composting, and reclamation. Compared to the concentration processes and those of ultimate disposal, these treatment processes are high-technology; their capital intensiveness is correspondingly increased. These are the areas now receiving the greatest attention from investors and municipal authorities.

The technology of compaction, beyond that found in the ordinary packer truck, is a recent development. So far, it is usually based on conventional baling equipment, sometimes combined with shredders. The costs are not yet well estab-



The technology we have applied to disposing of solid waste is primitive—yet the quantity to be disposed of will be nearly three times as large in 30 years. This figure counts up the tonnage from our urban areas.

lished, but it appears that a minimum of 50¢ per ton to over $2.50 per ton represents the typical range of capital and operating costs. The differences in price reflect partly economies of scale and partly the degree of treatment of the bale (wrapping material, preshredding, etc.).

Incineration is most common in metropolitan areas, where land-fill sites are scarce and where most trash is generated. Some 20 to 25 per cent of the commercial and domestic waste generated in the urban centers is presently so treated; almost 30 per cent will be burned by the year 2000.

The incinerator's primary function is to reduce the volume economically and to sterilize solid waste. Within the operating lifetime of many municipal incinerators, the technology of incineration has advanced from hand-stoked hearth units to contemporary, mechanically-stoked waterwall boilers. Federal assistance through demonstration grants and the increasing urgency of the solid waste disposal problem will continue to accelerate the pace of design innovation. But ten years from now, most incinerators will still be those now in use or very much like them.

By the time trash is delivered to the incinerator, compaction has often occurred in the packer vehicle, so the density is about 15-30 lbs./ft.^{3} (about 540 lbs./yd.^{3}). In most incinerator operations, refuse is fed into a furnace in a free fall from an overhead charging hopper and gate or by an underfeed stoker from a refuse-filled feed chute. Burning usually becomes very intense; the material sequentially undergoes drying, ignition, and pyrolysis, and char oxidation. Usually a second burning chamber is used to assure more complete burnout of combustible materials such as hydrocarbons, soot, tars, and carbon monoxide. Some new plants include convection passes over water-filled tubes. Superheating of the steam has been attempted in some European plants. Heat-recovery developments have been hampered by corrosion problems, apparently due to hydrogen chloride (which forms as polyvinyl chloride burns), and the reducing atmosphere occasioned by incomplete burning of the combustion gases. These problems are largely solved by improving mixing and high-temperature refractory protection.

Other parts of the incinerator are also vulnerable to acid attack: the gas cooling device, which can be either a convection boiler system or a water-spray evaporative cooler, and the air pollution control device and stack, which usually has substantial areas of unprotected metal.

Stack gases from the incineration process must be cleaned and cooled, and scrubbers and evaporative flue gas conditioning systems represent a substantial cost and present substantial potential for water pollution. Many of the problems associated with these devices are caused by acids in the stack including hydrogen chloride, sulfuric, and organic acids. The high acidity of water—as low as pH 2 after a single pass to cool and clean the stack gas—and high chloride content result in rapid degradation of unprotected metallic surfaces and pipes. These problems have already caused catastrophic failures in scrubbers and fans. Because of projected increases in the use of polyvinyl chloride, there is great concern about the proper design and choice of materials to cope with this corrosion problem in future incinerators.

A number of new concepts in incineration are now under investigation. They include slagging incinerators, wherein the residue is fused to obtain a coarse sand-like material; concepts based on pyrolysis; and processes using fluid bed combustion. Although considerable interest has been shown in these approaches, none has yet been demonstrated in a full-scale plant in the U.S. (a step that will govern how quickly they come into wide use).

Alternatives to Burning

Instead of burning (or before it) the trash may be milled, shredded, or pulverized into uniformly sized particles. This costs between $1 and $3 per ton processed, depending on the size of the particles resulting and the economics of the scale of operations.

Shredding is preliminary to some recovery processes, and flotation processes or ballistic separation have been suggested to concentrate, if not purify, plastics or other materials in shredded trash.

The organic matter in refuse, although of little value as fertilizer, can be composted. A number of operations are available for degrading refuse, or a cleaned part of it, to a humus-like material. Composting has not, however, been commercially successful because of difficulties in marketing. Indeed, many composting plants ceased operations when they found that large fractions of their processed material were dumped directly in landfill sites. The process does not seem economically viable, at least on a wide scale, in the United States.

Reclamation—or recycling—of inorganic matter is now practiced at a number of landfill and incinerator

locations throughout the United States. Although in most locations only modest portions of the paper, glass, and ferrous metal values are salvaged, the public and all levels of government are spurring attempts to expand the scale and scope of reclamation. (New machines for reclamation are discussed at length by Professor Wilson in the next issue, and some of the issues in reclaiming metallic wastes are described by Dr. Howard Cannon in the same edition.) Developing good markets for the reclaimed material remains a major problem.

There Is Rubbish Yet

Eventually a point is reached in all processes where further reduction of volume of the waste material by compaction or sorting is simply too costly. Then, the solid waste is delivered to a landfill or, in a few instances, transferred to barges for subsequent ocean dumping.

The practice of "landfilling" ranges from open, burning dumps to truly sanitary landfill operations. Basically, the refuse is spread upon the ground and sometimes compacted by burning or by a compaction vehicle. In less than 20 per cent of the operating dumps, each day's accumulation is thoroughly covered with a layer of clean earth. In a smaller portion of the total, attention is given to the leachate—high in biological oxygen demand and dissolved salts.

Compared to incineration, direct disposal by landfill is low in cost and landfill is preferred when land is available. The variations in cost probably reflect the costs of transport for different distances.

Ocean dumping is not yet widely practiced. This reflects our concern for its effect on the ocean, the availability of land disposal sites, and its high cost compared to landfill. (Ocean dumping of sewage sludge costs New York City about $2.74 per ton versus $1.12 per ton for fill.)

Can Incinerator Residue Be Reclaimed?

The residue from an incinerator represents a small "resource," of modest interest for at least two reasons:

☐ The residue is comparatively free of organic matter and is thus a concentrate of metal and non-metal values.

☐ It is or can be readily made quite dense and relatively cheaply transported.

A significant effort has been made by a number of public and private groups to make use of incinerator residue. Slagging incinerators, for example, produce a material which appears suitable for roadbed or low-strength aggregate. Also, incinerator residue (like many other ash materials) can be hot-spun into rock-wool insulation and the like. These applications, however, would appear to extract only the most rudimentary values in incinerator residue. A report from the U.S. Bureau of Mines emphasizes that municipal waste residues should not be considered worthless solid waste. They constitute a valuable mineral resource, richer in metal than many ores. The Bureau notes the problem: "the metals in incinerator residues are mixed physically and chemically in combinations not normally encountered by extractive metallurgists. Research is urgently needed to develop methods for recovering and refining these metals to prevent further waste of a valuable, readily available raw material."

Data on residue composition are in short supply. What data we have suggest that metallic values exist to a large and fairly consistent extent in incinerator residue. The recovery and recycling of the metallic values could provide a source of revenue to the municipalities or to salvage firms serving several communities. For this purpose, the fine ash fraction may be even more valuable.

The description in this article is intended to suggest that the means which we have developed over the years to cope with solid waste are at best primitive in respect to technology. This is a result consistent with the lack of incentives and risk-taking characteristic of municipal governments—factors which in general inhibit their support for the rapid expansion of technology.

But the initiative need not remain solely with government for, when viewed as a problem in materials handling, pyro-processing, and resources recovery, solid waste management would seem to link well with the skills and experience of the extractive and secondary materials industries and thus may merit review as a business opportunity. Certainly, this challenge is everpresent, growing, and of increasing importance to us as individuals and as a country.

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The Unsolved Problem of Nuclear Wastes

While the nuclear power industry expands, we have as yet only interim procedures for disposing of its high-level, long-lived radioactive wastes. The salt mine in Lyons, Kansas, is less an answer than we hoped.

Radioactive waste containing numerous radioisotopic products is generated in processing irradiated nuclear fuels at plants operated by the Richland, Savannah River, and Idaho Operations Offices of the Atomic Energy Commission, as well as at the commercial plant of Nuclear Fuel Services, Inc., at West Valley, N.Y. Oak Ridge National Laboratory has generated high-level liquid wastes at its radiochemical-processing pilot plant and is currently generating such wastes at its transuranium-processing facilities. Additional commercial fuel reprocessing plants are being built, and more will be needed for processing the increasing amounts of irradiated fuels which will be produced in an increasing number of nuclear-powered electric plants. Indeed, the waste from these plants will amount to an estimated 60 million gallons by the year 2000.

The potential hazards from these radioactive wastes derive from the basic characteristics of the radioisotopic contaminants. Many radioisotopes decay rapidly; some decay at such slow rates that they represent potential hazards to mankind for centuries, and allowing these radioisotopes to decay naturally is the only practical means of reducing their radioactivity to nonhazardous levels. The isotopes that are of greatest concern are those which are highly toxic and have long lives, including strontium-90 and cesium-137, which require hundreds of years to decay, and plutonium-239, which has a half-life of 24,000 years and requires more than 250,000 years—five times the history of man on earth—to decay to an innocuous level.

Such high-level, long-life materials cannot be released into the environment because of their high radioactivity, which may be as much as 10,000 curies per gallon in the solutions in which they occur. These toxic radioisotopes can be separated from the lower-level radioactive materials and from the stable compounds with which they are associated in nuclear waste, so that the latter may be disposed of in more conventional ways.

To confine and isolate high-level liquid wastes, the Atomic Energy Commission has stored them underground in large, steel-lined concrete tanks and in steel tanks within concrete vaults. These liquid wastes from A.E.C. operations, which now amount to some 80 million gallons, require continual surveillance, and storage in this manner can be considered only an interim solution.

At present, the A.E.C. plant at Richland is proceeding with removal of strontium-90 and cesium-137 from high-heat liquid wastes, leaving the remaining materials to decay to low-heat liquid within about five years; and Richland is developing a process to construct a facility for solidifying and encapsulating liquid strontium and cesium concentrates. The low-heat liquid wastes are solidified into salt cakes in tanks—a storage process which must be regarded as temporary until its acceptability can be determined.

The Idaho National Reactor Testing Station is converting liquid waste to a granular, calcined material which is stored in stainless-steel bins in underground concrete vaults—also an interim storage process. At Savannah River, wastes are segregated on the basis of their heat-generation rates and are immobilized in tanks by evaporation to salt crystals and sludges.

According to the A.E.C., burial practices followed by Richland, Savannah River, Idaho, and Oak Ridge have not resulted in releases of radioactivity beyond the confines of the burial grounds. But there have been problems: in 1968 Richland was faced with a potentially serious situation with respect to its existing tanks, for some leaks had been detected; at Idaho, the burial grounds have been inundated on occasion by water from melting snow. Fortunately no similar problems have been reported at Savannah River; a leaking tank there would be more serious than at Richland because the leakage would be expected to migrate into ground water.

Deep-Cavern Storage Concepts

The du Pont Co., operator of the Savannah River plant, has proposed that radioactive, separation-process waste be permanently stored in caverns to be excavated in bedrock at the plant site. The concept suggests that storage for 100 million gallons of waste can be excavated in bedrock, approximately 1,500 feet below grade. The proposal calls for six storage tunnels arranged in three pairs; after each storage tunnel is ready to receive waste, it is to be sealed from an access tunnel by impervious bulkheads designed to withstand hydrostatic pressure at tunnel depth. The tunnels are to be constructed in predominantly Pre-

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Many radioisotopes decay rapidly; some decay at such slow rates that they represent potential hazards to mankind for centuries. . . .

cambrian and Paleozoic metamorphic gneiss and schist, which are relatively impervious but exhibit some fractures and fissures. These fracture and fissure zones can be sealed by grouting, and it is predicted that the migration of radioactive constituents from the storage facility would be so slow that no harmful contamination of off-site water would occur.

In giving this assurance, du Pont cites the low hydraulic gradient of bedrock water at the site, the low solubility of plutonium, and the high density of the waste fluids as compared with groundwater. Geological, geochemical, hydrological, and economic aspects of the project have been investigated for almost eight years. A review panel of the National Academy of Sciences in May, 1969, concluded that the storage proposal has sufficient promise to justify construction of the shaft and several tunnels in order to determine the severity of the fracture problem. Yet in 1966 a majority of the Committee of the Earth Sciences Division of the National Academy of Sciences expressed strong reservation concerning the bedrock concept of waste storage and recommended that the investigation be discontinued. More recently, a prominent member of that Committee reportedly observed that the proposed storage at Savannah is a "disaster looking for a place to happen." The A.E.C. has decided, however, to perform the additional studies because of the cost differential between bedrock storage and other alternatives.

Deep-cavern storage also has been proposed for Richland as an alternative to long-term storage of solidified waste in tanks. Studies were begun in 1969 to determine the feasibility of isolating wastes in caverns mined into basalt, 2,000 to 4,000 ft. beneath the site. According to this concept, salt cakes resulting from in-tank solidification of liquid waste would be removed from the tanks in the dry state, water would be added in the transfer system, and the slurry waste would be transported to the underground caverns. Richland is conducting a program of exploratory drilling to secure geological, hydrological, and other physical data to be used in evaluating the suitability of these subsurface rocks for waste storage.

Waste-Storage by Vulcanism

In July, 1971, Cohen, Lewis, and Braun of Lawrence Radiation Laboratory proposed a method for disposing of nuclear reactor wastes by *in-situ* incorporation in molten silicate rock. The proposal suggests injection of liquid wastes into a chimney by a 5-kiloton nuclear explosion at approximately 2,000 meters depth. The waste would be permitted to self-boil, and the resulting steam would be recycled and processed in a closed system. When waste addition is terminated, the chimney would be allowed to boil dry, thereby solidifying the wastes. The heat generated by the radioactive waste would then melt the surrounding rock, which would dissolve the waste. Finally the rock would refreeze, trapping the radioactive material underground in an insoluble rock matrix.

The authors claim safe, permanent, and timely removal of radioactive material from the biosphere at relatively low cost, elimination of the need for waste transportation by siting in the immediate vicinity of the reprocessing plant, and waste injection with minimal or no treatment. Waste addition at a rate 1,500 tons per year for a period of 25 years is contemplated.

The concept has been described as interesting and worthy of further study by numerous reviewers. However, it has been criticized on the grounds of conflict with the concept of recoverability, and there seem to be serious doubts about the insolubility of the rock matrix, the possibility of differentiation of the isotope mixture permitting plutonium to concentrate in a near-critical mass, geochemical alteration of the drill hole and casing, and gaseous-phase transport of such elements as ruthenium (as the tetraoxide). Obviously, much research is necessary.

Salt-Mine Storage

Salt formations attracted the attention of a National Academy of Sciences committee in 1955 because salt is abundant, can heal its own fractures by plastic flow, transmits heat readily, and exhibits compressive strength and radiation shielding properties similar to those of concrete. However, studies relating to salt storage were not initiated until 1959 at Oak Ridge, and not until 1963 were studies undertaken in Kansas. In that year, the A.E.C. chose a mine of the Carey Salt Co. at Hutchinson, Kansas, for study of salt properties, and this study was subsequently extended to the abandoned Carey salt mine at Lyons in work known as Project Salt Vault.

The works at Lyons utilized engineering test-reactor fuel assemblies, along with heaters, to create an environment that would be similar to that expected in a real repository. The mine was instrumented with devices for recording heat, radiation, and physical properties. Subsequent selection of the Lyons site in 1970 as the actual storage location was

. . . salt is abundant, can heal its own fractures . . ., transmits heat readily, and exhibits compressive strength and radiation shielding properties similar to . . . concrete.

based partly on the success of these tests and partly on research from the nearby Hutchinson mine. Other determining factors included the seismic stability of central Kansas, the availability of a 300-ft. section of salt overlain by 800 ft. of rock containing impermeable shales, the generally flat-bedded character of the salt, the opportunity to use also the abandoned Carey mine for storage of low-level waste, and the hospitality of the people of Lyons.

Thus the abandoned Carey salt mine, plus an adjoining 1,000-acre site, became a proposed permanent repository for high-level radioactive waste.

Meanwhile, additional studies and design work on storage facilities and methods to transport the radioactive waste were proceeding at Oak Ridge National Laboratory. According to plans, liquid wastes from commercial reprocessing plants would be converted into solid form and placed in stainless steel cylinders which would be transported by rail in large shielded casks. Each cylinder, lowered down a shaft into a newly excavated salt mine at Lyons, would be placed in a hole in the floor of the mine. When an appropriate number of these cylinders had been placed in the mine, the entire room would be backfilled with crushed salt. Experimental evidence suggested that the heat generated in the radioactive waste would recrystallize the crushed salt, and both crushed salt and bedded salt would flow plastically so as to completely seal off the waste material. Other low-level radioactive materials consisting of contaminated clothing, lubricants, and laboratory ware were also to be stored in the abandoned Carey salt mine. There was some suggestion that granular, calcined waste from Idaho also eventually would be transferred to this repository.

Visitors inspect Project Salt Vault In the abandoned Carey Salt Co. mine at Lyons, Kansas. The project studied the suitability of salt deposits for the long-term storage of high-level radioactive wastes. (In this photograph, devices simulating such wastes are shown sunk into the floor of the mine.) For a time it appeared that the Carey mine would indeed be suitable as a high-level waste repository, but recent studies have led the U.S. Geological Survey to recommend against it. (Photo: Wichita Eagle and Beacon)

The Lyons Site: Swiss Cheese

The Kansas Geological Survey expressed serious concerns about the proposal. One concern related to the Lyons site itself; another related to the burial-in-salt concept.

Initially, the geology of the area was inadequately known. On the basis of Survey recommendations, the A.E.C. funded further geological studies. Numerous holes were drilled and logged at the site, and water samples were taken in all the holes and analyzed. This geological evaluation revealed a pressure sink on the water surface of a major aquifer, suggesting vertical circulation.

Other conditions were also revealed to demonstrate the inadequacy of prior investigations at Lyons. The abandoned Carey mine is located at a depth of 800 ft. on the north border of this town of approximately 5,000 people. One entry within the mine extends southward beneath the city. The only access to the mine is a vertical shaft which penetrates 40 ft. of saturated

aquifer and was constructed by use of a caisson. An entry in the mine of the American Salt Co., at the south border of the town, extends northward under the town of Lyons. The Carey entry and the American entry are within 1,800 feet of each other. The only access to the American mine is a vertical shaft, which also penetrates about 40 feet of saturated aquifer. The water from the aquifer is collected in a ring about 200 ft. down the shaft and pumped back to the surface.

Just to the southwest of its underground mining operation, the American Salt Co. also mines salt hydraulically by injecting fresh water, which dissolves the salt, creating caverns the full height of the salt; the resulting brine is returned to the surface for processing.

The area contains both abandoned and producing oil and gas wells, numbering into the hundreds. The locations of some of these old wells have never been determined, and surface subsidence has occurred in places where old casing has corroded and permitted surface and ground water to excavate caverns in the salt. Some of the resulting surface depressions are as much as ¼ mi. in diameter. Some of these wells penetrate deep Arbuckle rocks which contain fluids under sufficient hydrostatic pressure that the static water level in some wells stands higher than the level of the salt mines. It is clear that intersection of such an Arbuckle well by a mining operation will cause flooding of the mine. At least 29 wells have been identified on the site proposed to be acquired by the Atomic Energy Commission, and these must be completely cleaned out and replugged. We have reason to believe that other unidentified wells may be present. An abandoned shaft full of water, representing an earlier salt mining effort, has been located just west of Lyons.

During the past summer, the American Salt Co. intersected an abandoned oil well with a rock bit, preparatory to shooting the salt face. Although some water entered the mine, the hole was plugged satisfactorily. Somewhat earlier, the American Salt Co. lost all circulation during a hydraulic mining operation: following successful injection of fresh water and production of brine for five days, approximately 180,000 gal. of fresh water disappeared. The operation was terminated and no one can discover where the water went.

In other words, the Lyons site is a bit like a piece of Swiss cheese, and the possibility for entrance and circulation of fluids is great.

Other investigations revealed approximately 400 ft. of displacement in Arbuckle rocks, suggesting the presence of a major fault.

All of these factors have led the Geological Survey to recommend that the Lyons site be abandoned. An independent analysis by a committee of the Kansas Geological Society produced similar conclusions, as did an analysis of the Council of the Kansas Academy of Science. There is nothing more important than recognizing a dead horse early and burying it with as little ceremony as possible.

Salt-Mine Storage: No Answers Yet

As to the general concept of burial of nuclear wastes in salt, the jury is still out. The axial temperature of cylinders containing radioactive waste is about 930° C. This heat generated in the cylinders must be dissipated through the salt and other overlying and underlying rocks. We claim that the two-layer, two-dimensional heat-flow model used by the Atomic Energy Commission is overly simplified. A multi-layered, three-dimensional heat flow model is necessary for resolution of the problem, and this work is being undertaken at the present time.

Another problem relates to possible mine subsidence. The crushed salt used to back-fill the mine will contain approximately 30 per cent void space. Recrystallization and plastic flow of the salt could cause subsidence and shear in the overlying rocks, and this in turn might permit surface or ground water to penetrate the mine, dissolve the salt, and set up a thermal transport system. This situation is even more dangerous because the stainless steel cylinders are expected to begin to break down within three months, eventually releasing the waste.

Likewise, the rock mechanical model used for studies of mine subsidence is overly simplified. Many rock properties are temperature-dependent, and even dewatering of shales could create problems. Radiation damage and subsequent release of energy as a thermal excursion, with respect both to the salt and to the radioactive waste itself, is an important subject as yet improperly investigated.

Appropriate studies should reveal whether or not radioactive waste can be stored safely in salt. Since the result may well be affirmative, the Kansas Geological Survey has undertaken additional reconnaissance of other areas in Kansas for possible storage of radioactive waste. The study is concerned with eight large areas that seem to be underlain by salt beds at least 200 ft. thick, no deeper than 2,000 ft.

In other countries (except Germany), as far as we can determine, high level radioactive waste is being stored at or near the surface. But for the U.S., nothing is more important than recognizing a dead horse early and burying it with as little ceremony as possible.

and no shallower than 500 ft. These areas contain a small number of oil and gas wells, salt mines, storage cavities, and pipelines, and a small population. Our result is information regarding salt and overburden thickness, salt quality, ground-water conditions, regional geological characteristics, mineral resources, and existing wells, salt mines, liquid-petroleum-gas storage cavities, pipelines, and population, and an evaluation of each area as a potential waste storage site. On the basis of these evaluations, the A.E.C. will determine if any of the areas justify further investigation. Because the areas contain few wells, information concerning the underlying rocks is sparse, and much additional investigation will be required before any of the areas can be determined to be suitable for radioactive storage.

A European View

Gisela Dreschhoff and Edward J. Zeller, Research Associates of the Geological Survey of Kansas, visited the Asse Nuclear Waste Repository in Germany late last year, and key staff members provided a complete review of that project. At present, low-level waste is stored in cavities in the Asse salt stock. Containers are released from shipping shields and lowered by crane into a chamber. Remote control facilities and television cameras permit movement and observation of the waste containers. No attempt is made to achieve symmetrical stacking. At the present time, nearly 10,000 casks of low-level waste, each having a limit of five curies total activity, are stored in two rooms at the 750-meter level.

High-level waste emplacement is planned at Asse for 1974 or 1975. The waste will be solidified in the form of glass cylinders approximately 20 cm. in diameter and one meter in length. These will be stacked vertically in bore holes in the salt roughly 50 meters deep in tunnels at the 750-meter level. After the bore holes are filled with 30 meters of high-level waste cylinders, a concrete plug will be poured and the upper part of the hole above the plug will be filled with crushed salt.

The Asse anticline is structurally stable and a massive gypsum cap rock can support the load of overlying sediments and serve as a shield for the underlying salt. Two nearby mines are flooded as a result of improper mining techniques. The Germans do not seem to be concerned, because the system has reached an equilibrium, no collapse has been observed near the old shafts, and no significant leakage has been determined. Even if water entered the mine, the Germans feel the water would be nearly saturated and would cause no problems. However, the presence of sinkholes and salt springs does indicate that some solution is taking place.

Extensive studies are being conducted at the Hahn-Meitner-Institut for Nuclear Research in Berlin and at the Nuclear Research Center at Karlsruhe, which my colleagues also visited. These studies are concerned with radiation damage and the problems of processing and solidifying nuclear waste in form suitable for storage in the Asse mine. Competent scientists are in charge of the programs, which appear to be free of irrational political influence. Mention was made of the desirability of greater interchange of information between the United States and Germany regarding matters related to nuclear waste disposal. Seemingly, there has been little exchange in the past four years, and direct liaison between the U.S. and German research and development groups should be established as soon as possible.

In other countries, as far as we can determine, high-level radioactive waste is being stored at or near the surface, as, for example, at Chalk River, Canada.

Long-Term Waste Management

For the fiscal year 1970, the A.E.C. was authorized $2.3 billion for its various programs. Of this amount, only $28 million (roughly one per cent) represented operating and capital funds authorized for waste management programs. The Government Accounting Office has said that to expedite the development of methods for placing high-level waste in long-term isolation, the A.E.C. should place greater emphasis on evaluating the actions taken by its contractors, determining the adequacy of long-term storage proposals, and taking the steps needed to accomplish long-term storage.

Meanwhile, the A.E.C. has yet to establish an overall, well-coordinated plan for resolving its waste management problems and achieving its objectives at all installations. In the past and currently, the A.E.C. management has given priority to the development of technology and applications in weapons production and reactor development which result in the generation of radioactive waste. There has been no comparable emphasis on long-term storage.

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The Dynamics of Solid Waste

Recent figures of the U.S. Bureau of Mines make clear that world mineral reserves are far from infinite. If we assume that demands remain at their present level, we can derive from the known-reserve figures a measure of lifetime, the "static world reserve indices" shown in the table. However, the per-capita consumption of metals in the United States increased by a factor of 9.6 in the period from 1870 to 1965—equivalent to 2.5 per cent per year, or a doubling time of 29 years. If we assume that this increase in demand continues (and it is actually significantly less than numerous present predictions) we obtain the "exponential indices" shown in the last column but one. The final column reveals an often-forgotten characteristic of exponential demand. Even if the real reserves are, for example, five times as great as are now known, exponential demand quickly outstrips them.

New reserves will be found, of course, but the potential is limited. In its first annual report, the Council on Environmental Quality expressed its concern in this way: "Despite spectacular recent discoveries, there are only a limited number of places left in which to search for most minerals. Geologists disagree about the prospects for finding large, new, rich ore deposits. Reliance on such discoveries would seem unwise in the long term. Extraction of minerals from some large reserves of very low-grade ores may become economically feasible in the future. However, the techniques of extraction themselves may pose significant environmental problems. For example, the power requirements for extraction may be immense. That would add to thermal pollution. In addition, the yield of waste products can be substantial."

The implication is that the industrialized world may in the future find difficulty maintaining its current high standard of living simply because of resource depletion, while the less-developed world may never achieve even our present level.

Possible Solutions

Feasible solutions for this problem are very few. We want both to slow down the consumption of natural resources and to reduce the rate of growth of our dumps. Thus an approach such as the use of biodegradable products only alleviates one half of the problem, the dump growth rate. In principle there is only one satisfactory approach—to reduce the rate at which natural resources are transformed into solid waste.

To speak precisely about controlling the flow of materials from resource to waste, we need a quantitative expression for its magnitude in tons/year. If we call the number of products in use P, and the average lifetime of the product (i.e. the number of years it is used) L, then the number of products discarded per year is P/L. And if the average amount of waste from each product is w, the solid-waste generation rate is Pw/L in the steady state.

Thus there are in principle only three ways of reducing the solid waste generation rate:

☐ We can reduce P, the number of products in use.

☐ We can increase L, the products' lifetimes.

☐ We can reduce w, the amount of solid waste in each product.

The first approach implies a deliberate reduction of the material standard of living. This may be necessary in the long run but is probably not politically feasible now.

To increase the useful lifetime of the products means curbing the "throw-away/no return" and "planned obsolescence" tendencies of our economic system. The most obvious way of doing this, of course, is to construct products so that they last longer. A second alternative is to design products to be easily and cheaply repaired (and to ensure that there are enough repairmen and service-centers). A third alternative would be to induce people, by deliberate economic and social incentives, to keep their products longer. But this might not make much difference in practice. Though many people sell or throw away products needlessly early, simply because they like to have new and exciting things and can afford them, the products they discard are often picked up and used by others. This goes on until the product is completely useless, so the real limiting factor may be the product's total lifetime, rather than how long each owner keeps it.

It is important to realize that one does not necessarily have to increase the production rate in order to increase the number of products in use and hence the material standard of living. Increasing a product's life-

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All industrialized countries have an urgent "solid-waste problem." The problem, which is characterized by an ever-increasing solid-waste generation rate, has two aspects: a pressing shortage of dumping areas, and rising depletion of non-renewable natural resources.

Resource	*Known reserves*	*Static index (years)*	*Projected rate of growth (per cent/year)*	*Exponential index (years)*	*Exponential index calculated using 5 x known reserves (years)*
Aluminum	1.17×10^9 tons	100	6.4	31	55
Chromium	7.75×10^8 tons	420	2.6	95	154
Coal	5×10^{12} tons	2300	4.1	111	150
Cobalt	4.8×10^9 lbs.	110	1.5	60	148
Copper	308×10^6 tons	36	4.6	21	48
Gold	353×10^6 troy oz.	11	4.1	9	29
Iron	1×10^{11} tons	240	1.8	93	173
Lead	91×10^6 tons	26	2.0	21	64
Manganese	8×10^8 tons	97	2.9	46	94
Mercury	3.34×10^6 flasks	13	2.6	13	41
Molybdenum	10.8×10^9 lbs.	79	4.5	34	65
Natural gas	1.14×10^{15} ft.^{3}	38	4.7	22	49
Nickel	147×10^9 lbs.	150	3.4	53	96
Petroleum	455×10^9 bbls.	31	3.9	20	50
Platinum group	429×10^6 troy oz.	130	3.8	47	85
Silver	5.5×10^9 troy oz.	16	2.7	13	42
Tin	4.3×10^6 long tons	17	1.1	15	61
Tungsten	2.9×10^9 lbs.	40	2.5	28	72
Zinc	123×10^6 tons	23	2.9	18	50

This table summarizes the known reserves of some important resources and shows some measures of how long they are likely to last. The static index is simply the presently-known reserves divided by the present rate of consumption. The exponential index is a similar but more realistic measure, allowing for growth in consumption at the annual rate shown. The last column shows that, even if the reserves are really much larger, in most cases this makes only a small difference to how long they will last if consumption continues to grow exponentially. (Data: *Mineral Facts and Problems*, 1970, U.S. Bureau of Mines)

time achieves the same effect.

The third strategy—to reduce the amount of raw material in each product—seems at first sight to be an effective way of reducing the solid-waste generation rate. However, in many cases the lifetime of the product decreases when less material is used. Thus the solid-waste generation rate (Pw/L) might in some cases even increase as a consequence of reducing w. One example of this is children's toys, in some current examples of which so little material is used that they tend to become useless almost immediately. Most producers are already cutting product costs by using minimal amounts of raw materials. Hence it might be detrimental to introduce restrictions on materials or general taxes based on the weight of a discarded product. Nevertheless, such a tax would be very beneficial in relation to packaging, which constitutes most of the litter and 70 per cent of the household wastes collected in the U.S.

There is another way of effectively reducing w—recycling. The essence of this strategy is to throw away only a small fraction of the components of a product at the end of its useful life and return most of them to the "resource" end of the material flow. Preferably this method should be coupled with a general increase in product lifetime, through better construction of appliances and re-use of containers and other single-use products (as long as this does not require dispropor-

tionate increases in material per product).

Resistance to Change

But how to effect a transition from the present wasteful society to a society that recycles most of its wastes? Surely such a change is easier in theory than in practice. The enormous investment in present-day industry (including mining) geared to the present consumption pattern is a basis of significant resistance to change. So is the consumer's assumption that it is reasonable for him to purchase anything he wants, regardless of whether it lends itself to disposal or recycling, and to throw it away afterwards, more or less wherever he pleases and at no cost.

A forced change toward less raw-material consumption, less solid-waste generation, and more recycling will clearly affect society in many important ways. Because such a forced change is likely to meet substantial opposition, its proponents should be able to test different possible policies in advance, so as to eliminate at least the most obvious mistakes. For instance: To enhance recycling, is it more effective to tax the mining industry or to give subsidies to the recycling industry? How important is it to directly encourage recycling now, rather than to wait until the processes become profitable and the concept "takes off" unaided? Will economic incentives work to conserve resources for the long run while the cost of raw materials is still low relative to the price of the finished goods?

In order to answer these kinds of questions, and also to substantiate the intuitive considerations mentioned above, we have devised a mathematical working model of the resource/waste situation with which we have conducted a number of "policy experiments."

The discussion above identifies a general area, but it is not sufficiently limiting to provide the focus for constructing a useful model. The detailed questions we shall address center upon the processes of material flow from virgin and recycled resources into solid waste over a time span of about 100 years. This period is useful because, within it, one can foresee significant changes in the costs of extraction and in usage and recycling patterns. On the other hand, by choosing such a time horizon we necessarily exclude all kinds of short-term variations, such as the daily fluctuations in the copper price or seasonal fluctuations in production. What we retain are the general "trends" of the material-flow system.

The type of questions we shall want to answer will be: What determines the size of this flow of material? What determines the proportions of virgin and recycled material in the flow? How can one increase the recycled fraction? How can one slow down the solid-waste-generation rate? What advantages are there to deliberately and immediately increasing the recycled fraction, above the dictated by purely economic incentives?

The Model's Limits

We focus on the dynamics of a single natural resource, and we attempt to understand questions such as those above by generalizing our knowledge into a model. Throughout this paper copper will be used as an example, but it is very important to realize that the underlying model structure is appropriate for any nonrenewable commodity that can be recycled; only the numbers need be changed.

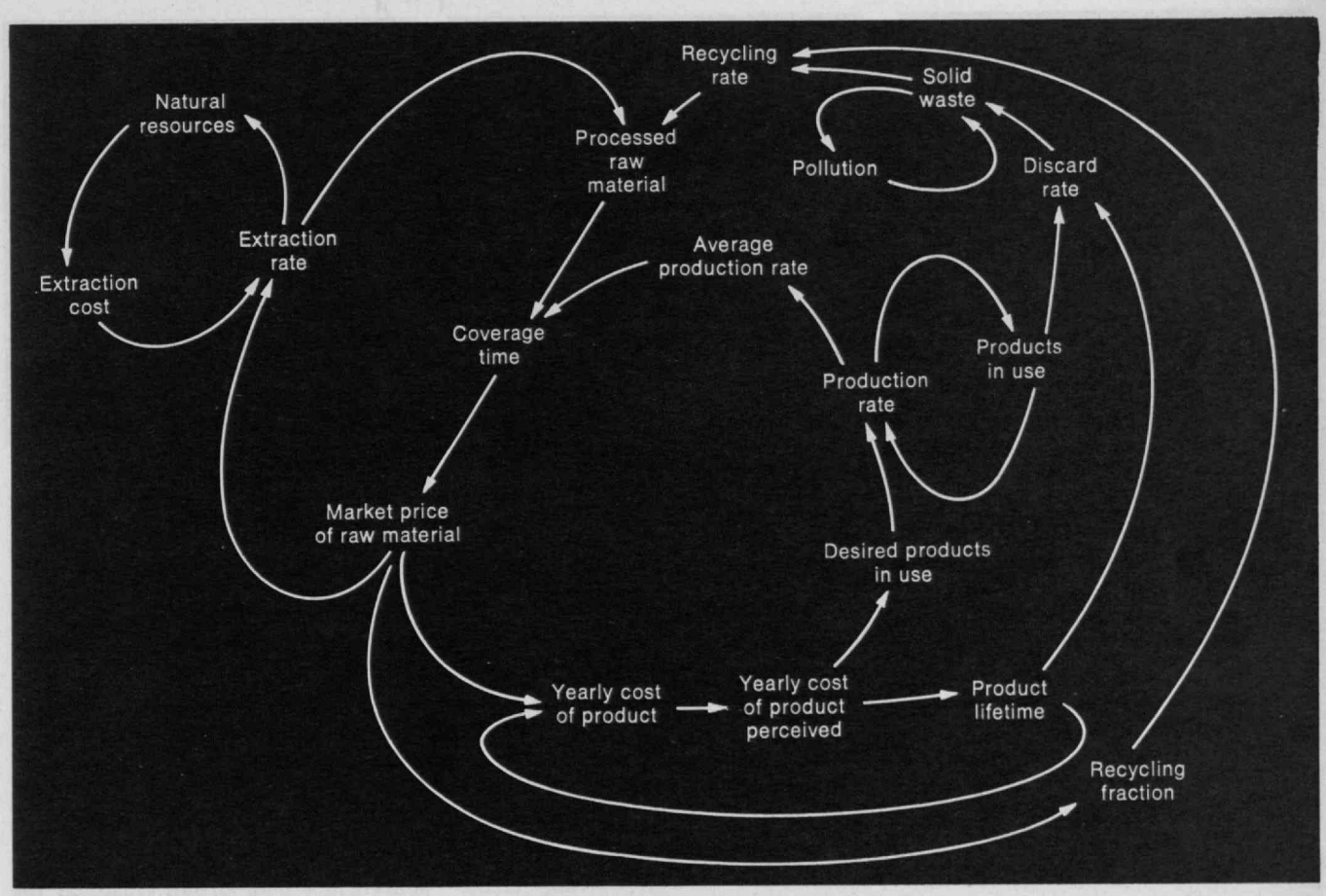
This specialization on one raw material means that our "product" is defined as the usual mixture of objects made from one ton of raw material—in this case, 36 per cent wire, 48 per cent tubes and sheets, 15 per cent castings and one percent powder. We look at the copper market as a whole. We are concerned neither with the competition among individual firms producing the same product nor with the behavior of individual consumers.

We assume that the level of the industry's output is determined only by the demand for the product. In reality, this demand is itself a function of quality, price, and convenience in use; and demand also depends on factors such as marketing efforts and the average affluence of the consumer. But for our purposes we assume that all of these factors are constant except price, and that for a given price there exists a specific level of demand.

In fact, of course, growth in population and in per capita buying power will alter the demand-price relationship. Such effects can easily be built into the model, but they are eliminated from the basic version so that it more clearly reveals the effects of waste generation alone.

We also assume that all other production factors (energy, management, storage, and the rest) are not importantly limited—in other words, if there is enough raw material, the industry will always contrive to satisfy demands (after the delay necessary for expansions or lay-offs). Again, this assumption is made only to clarify the results, and the model could easily be expanded.

Finally, the model does not explicitly include advances in technology.



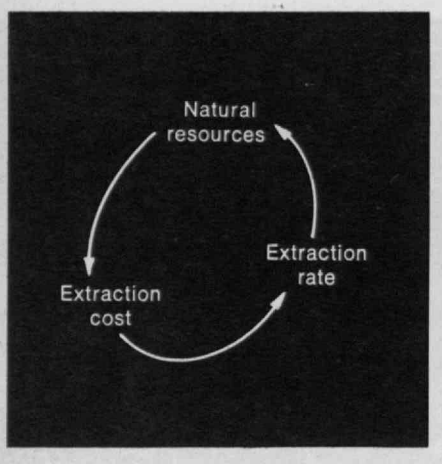
Preparatory to building a model of the resource-use system, the cause-and-effect linkages in the system are mapped out qualitatively. Each arrow indicates a cause-effect relationship. Individual cause-and-effect loops in the larger system thus become identifiable, and each can be analyzed in its relation to the others.

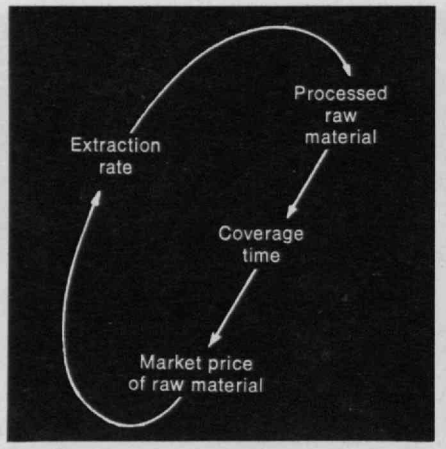
Advances in extraction and recycling technology are important, but their effects may adequately be studied in the model by varying the numerical values they would affect and then observing how much difference these changes make to the outcome.

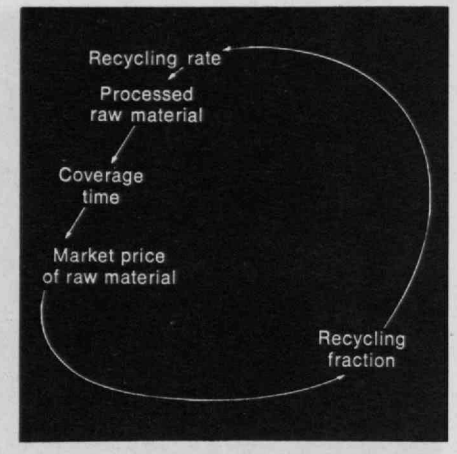
The Feedback Loops

The model is, in essence, a collection of relationships among variables. These are all the variables whose values change with the passage of time due to mutual interaction. There is a two-way causal relationship—a feedback loop—between each of these variables and the rest of the system; they change the rest of the system and are changed by it. Given the initial conditions (the initial values of these "state" variables) and their interrelationships (the system structure), their values in the simulation are determined for all of the future.

The feedback loop structure of the natural-resource/solid-waste system is shown in the chart at the top of this page. This is a diagram of causes and effects; it is not a diagram of material flow-paths, although in some areas it may look rather like that. We will now proceed to consider the individual loops one by one and in this way come to understand how a change in one part of the natural-resource solid-waste system affects other parts of that system.







The Natural Resource—Extraction Cost Loop (above) simply suggests that a decrease in the amount of copper ore remaining results in an increase in the extraction cost per ton of copper (if we assume that no new extraction techniques are being used). This, in itself, tends to reduce the rate of extraction.

In this connection it is useful to comment briefly on the role of technology. When future resource scarcity is predicted, people tend to suggest that technological advance will solve the problem for us. Historically, new techniques have provided less and less expensive ways of mining existing reserves and more efficient ways of finding new ones. Copper is a good example. The grade of ore mined has been steadily decreasing while the price has increased only slightly. However, this has been done only by using much more energy per ton of copper extracted. This process cannot continue indefinitely.

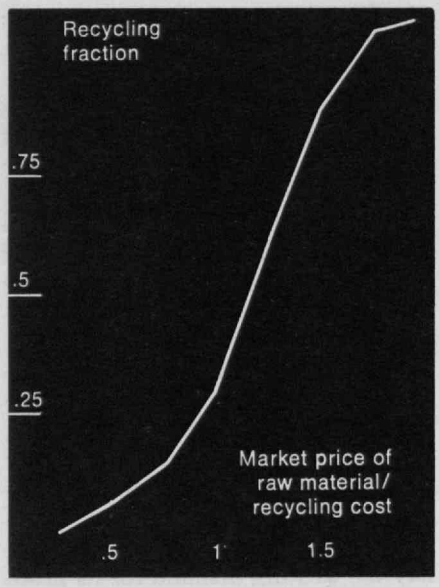
Ultimately the cost of mining one ton of copper must increase as resources are depleted. This is the relationship postulated in the model.

The adjacent *Market Supply and Demand Loop* (shown in the center column of this page) interrelates the extraction rate, the stock of processed raw material (i.e., the amount of the resource—natural or recycled—which has already been refined to the point where it is ready for manufacture into products), and the market price of the raw material. When the latter increases the extraction rate increases, tending to enlarge the stock of processed raw material. One measure of this stock is the "coverage time"—the number of years the stock would supply consumption at its current rate. If the coverage time becomes needlessly great, holders of the stock will lower the price they will pay for more of it: the market price of raw material, which initially rose, will decrease.

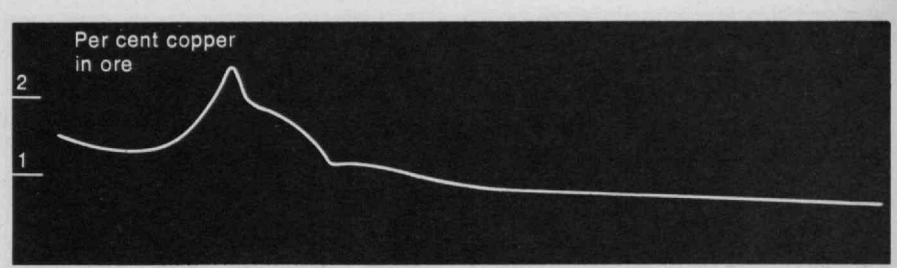
However, there is another process by which the stock of processed raw material can be increased—by recycling. This possibility is represented as the outermost loop—the *Recycle Loop* (in the right hand column, above). Here the market price of raw material determines the recycling fraction—that fraction of the existing solid waste which is re-used in a year. For example, a recycling fraction of .05 means that 5 per cent of the total inventory of copper scrap—be it in dumps, in junkyards, or in the radiators of abandoned cars—is recycled every year. (This is not the same as the percentage of all copper used in production which is recycled; but the latter can easily be computed if required.)

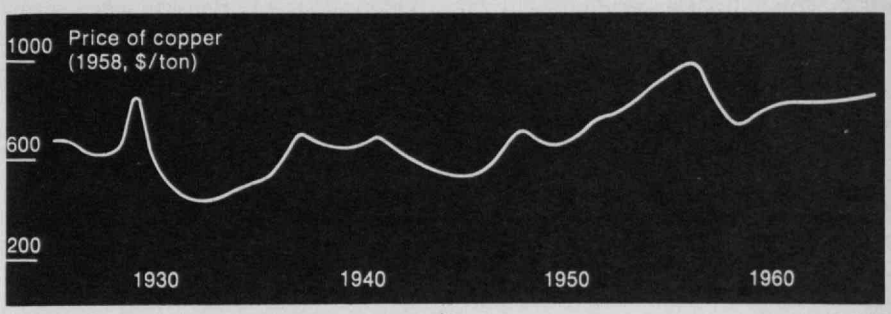
The recycling fraction is governed by the relationship between the market price of raw material and the cost of recycling. The latter consists mainly of the cost of collecting and sorting—work of a kind which still is labor-intensive. The cost of collecting a ton of urban waste in the U.S. is roughly $20, and the cost of handsorting it is very roughly $10. Hence, if there is only 1 per cent copper in the waste and the rest of the garbage has no significant value, recycling the copper would cost about $3,000 per ton. The market price of one ton of copper is typically $700 per ton—the lower cost being possible because the extraction of virgin natural resources has been automated.

Industrial waste is important because it is less expensive to recycle. Indeed, there is in fact a hierarchy of sources for recycled material, all differing in cost. Even at low market prices it will be economic to recycle



At present, the cost of extracting copper from most dumps is far above the market price of the raw material. In consequence, the fraction of the total accumulated "copper dump" that is re-used each year is very small. When the market-price/recycling-cost ratio increases—as it eventually must—the recycling fraction will also increase, in the manner shown here.



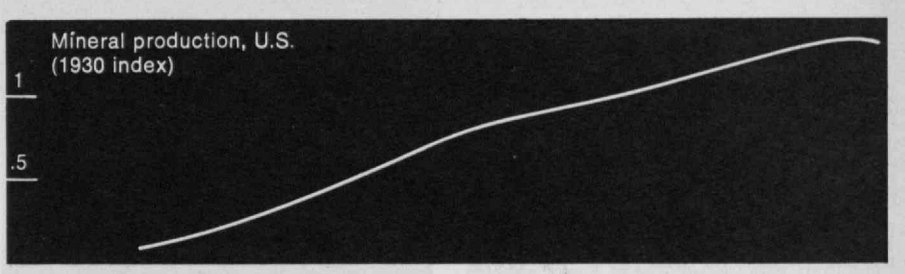


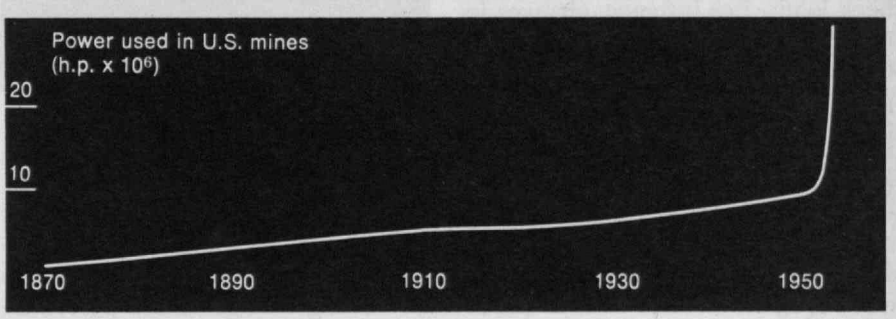
Technological improvements in mining have allowed lower and lower grades of copper ore to be mined, without very large consequent increases in the dollar price of the metal (*Resources and Man*, National Academy of Sciences—National Science Foundation, p. 124).

some waste—mill scrap, for instance. As prices rise, more and more kinds of waste become profitable sources of material, and the recycling fraction increases.

General Behavior of the System

These three interconnected loops describing the natural and recycled resource supply and demand are sufficient to understand the main processes which govern the behavior of a solid waste system. To start with the market price of raw material is low, and the demand for raw material is satisfied primarily by extraction. As time goes on the natural resource is gradually depleted, and the extraction cost rises steadily. The cost of recycling, on the contrary,





Although the dollar price of copper has not risen dramatically, the new mining technology is energy-intensive. The energy-cost of the metal cannot be allowed to continue rising indefinitely (*Resources and Man*, p. 122).

stays relatively constant (it may even decrease as waste accumulates, providing economies of scale). As extraction cost rises, recycling becomes profitable to satisfy a larger fraction of the demand. In the end extraction will essentially come to a stop, since the cost of extracting the small part of the natural resources that remain in the ground will be prohibitive. At this point, use of the material will depend solely upon reusing existing supplies—i.e., recycling of waste.

But recycling is inevitably less than 100 per cent effective; even a constant annual demand cannot be satisfied by recycling. Whenever a ton of copper is put through a use cycle, there is some loss; some part of the material becomes so finely dispersed in either water, air, or soil that it is lost forever. For this reason we restrict the term "solid waste" in the model to mean that part of the waste that is recoverable. We use the term "pollution" for that part of the waste irretrievably lost.

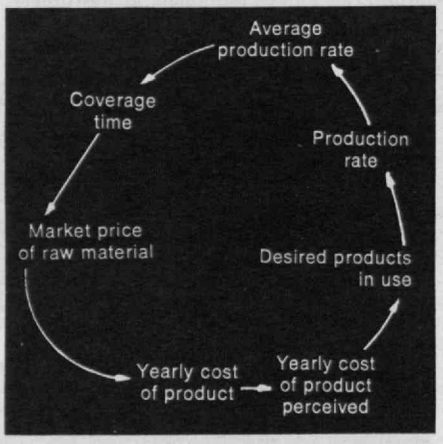
Products in Use

Although these three loops are sufficient to give the general behavior of the system, answers to the questions we posed require the inclusion in the model of several other feedback loops. For instance, changes in the market price of raw material affect the prices of manufactured products. A change in the market price of the product is important because it affects the demand for the product—in two very different ways. First, a lower price results in a tendency among consumers to stock more of the product—it increases the number of units in use at any point in time. Second, a lower price leads users to place less emphasis on repairs, thus lowering the product's lifetime.

The relative strengths of the two effects varies from product to product. Copper products (electrical wiring, tubing, etc.) are dominated by the first, stockpiling effect.

Closer consideration shows that, basically, the purchase price of the product does not in fact determine the number of items in use at any point in time and their lifetime in the hands of each user. The distribution of the product depends primarily on the cost of using it per time unit. One is willing to pay more for a product that lasts longer, and every consumer knows that true cost is found by dividing the market price of a product by its lifetime.

But it takes some time before a change in the yearly cost of a product is perceived by the consumer; no buyer knows in advance how long



his product will last. Hence the demand for a particular product is governed not by its real, present yearly cost but by a delayed version of it. The perception-delay between a change in the actual yearly cost and a resulting change in the perceived value is found by econometric studies to be around 15 years in the case of copper products (*Economic Analysis of the Copper Industry,* Charles River Associates, Inc., Cambridge, Mass., p. 9).

The users' perception of the yearly cost of using a product governs what we may call the "desired number of products in use." As we have seen, this perceived cost is governed (along with the real yearly cost of use) by the market price of the product and by the product's lifetime.

When the desired number of products in use is compared with the actual number of products in use, the difference, clearly, is the number of additional products the market will absorb before it is saturated. The industry is simply trying to satisfy the existing demand for its product, but it cannot do this instantaneously—there is a finite "market saturation time," related to production rate. This may be written as

$$\text{Production rate} = \frac{P_D - P_U}{T}$$

where P_D is the number of products desired, P_U the number of products in use, and T the market saturation time.

And this is the rate at which the industry as a whole is turning processed raw material into finished products. The average production rate, in conjunction with the stock of processed raw material, governs the "coverage time" which, as we have seen, affects the market price of raw material.

This rather complex *Average Production Rate Loop* acts in a goal-seeking fashion: it tends to alter the desired number of products in use so that the production rate meshes with the stock of processed raw material to produce a stable price.

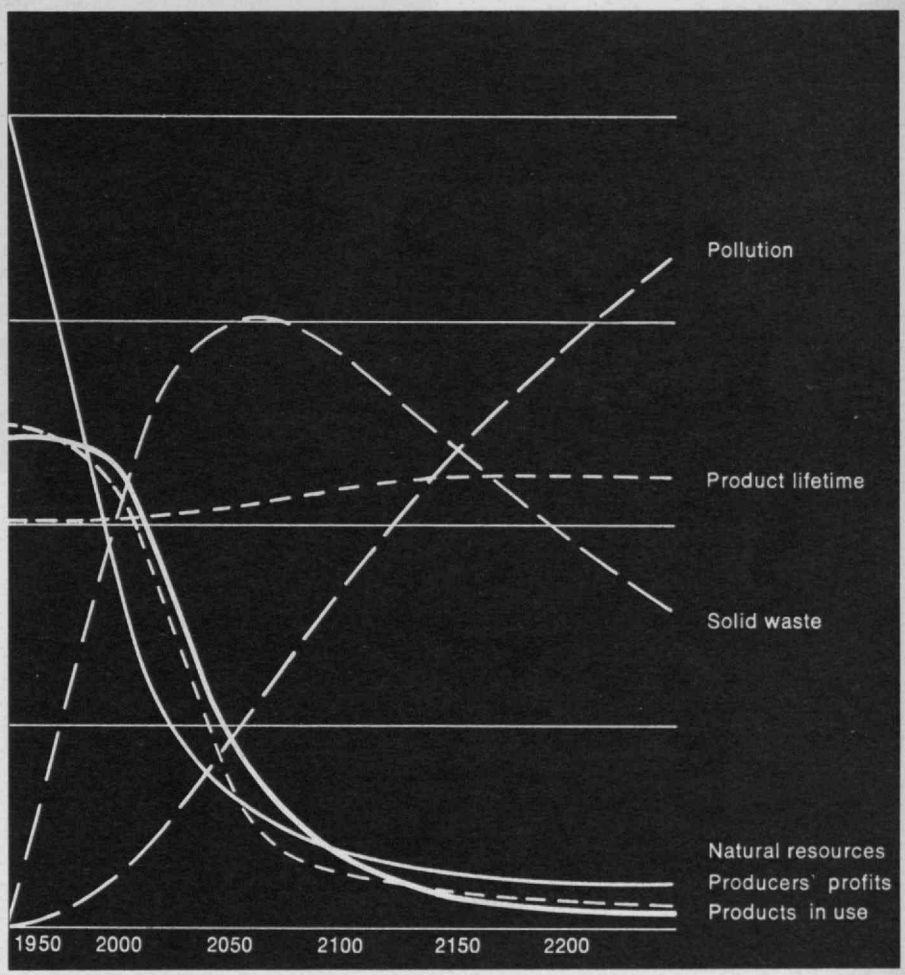
Price affects product lifetime, as we have seen. And the product lifetime

is important in connection with the generation of solid waste, since it determines the rate at which products are discarded. The average number of products discarded every year is simply the number of products in use divided by their average lifetime. A short product lifetime leads to a faster generation of solid waste.

Policy Experiments

Having justified the model, we are now prepared to use it as a predictor of system behavior. The detailed assumptions can be expressed quantitatively using the conventions of the DYNAMO computer language employed in most System Dynamics studies of this kind. From given initial conditions are computed the logical consequences of the total set of assumptions. In the following simulations with the model, it is important to remember that since variations in demand and technology have been excluded, no one quantitative prediction is significant. If, for instance, the result of one particular set of assumptions is a doubling of the recycling rate over the next 20 years, this does not in itself constitute a prediction, because we have neglected increases in demand. But if the simulation of a different policy results in a fourfold increase in the recycling rate over the same period, this difference is significant: we can conclude that the latter policy encourages recycling more than the former.

The initial conditions in all the examples are identical and are chosen so that, for the sake of general realism, a rough approximation to today's conditions in the copper market is reached around what has been called "1970" of each model run. (Today's market is characterized by a production around 6 x 10^6 tons/year consisting of roughly 70 per cent virgin and 30 per cent recycled material, a static reserve index of approximately 40 years, a copper price of about $700/ton, and an inventory of materials in use amounting to very roughly 120 x 10^6 tons.)



In the complete absence of recycling, the model shows these changes occurring as a resource becomes depleted. The number of products in use, and the producers' profits, decline catastrophically. The term "solid waste" indicates dumped copper which is still technically recoverable. After a time such material becomes irretrievable, and it is then (in this analysis) classed as "pollution."

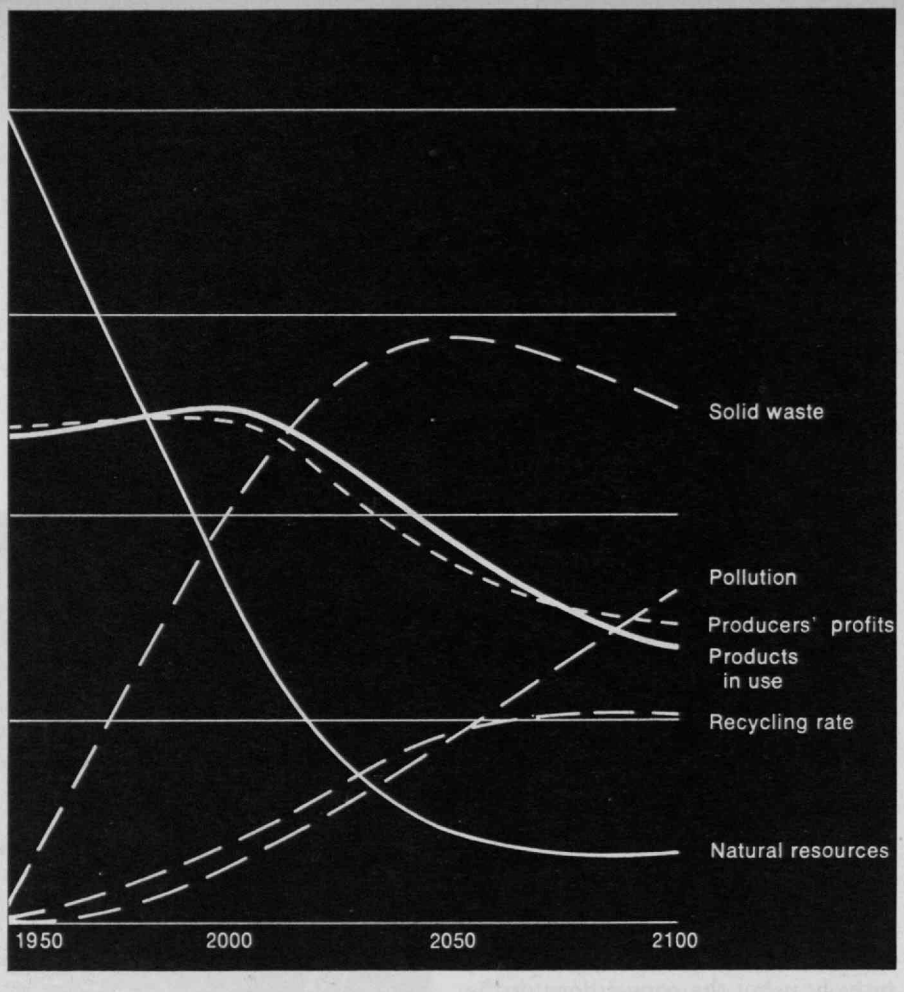
In the examples, all changes of parameters are made in "1970" except when otherwise indicated.

For the first example (*above*), we assume that there is no recycling during the entire period of the study, and we see the expected behavior: Natural resources are depleted while solid waste and pollution increase.

Solid waste decreases after "2050" but only because there is then a larger flow of material from solid waste to pollution than into solid waste from products in use. As the natural resources approach zero, the number of products in use is seen to fall rapidly—the diminishing extraction rate can no longer keep up with the discard rate, even though the latter decreases with the increased product lifetime. (This increase in product lifetime is caused by the increase in the market price of raw material as the natural resource grows scarce.) The producer's profit—i.e., the profit of the industry which transforms the raw material into finished products—falls catastrophically with the declining number of products in use.

If we assume a maximum recycling fraction of 1.5 per cent per year (which is close to the actual value—remember, this is a percentage of the total existing waste, not of the annual production) and run the model again, the advantages become obvious. The solid waste and pollution are somewhat reduced, and there are more natural resources left at the end of the run. But the difference is not enormous, because the availability of extra raw material through recycling results in there being many more products in use (or a higher material standard of living) throughout the run. The market price of raw material is lower and the product lifetime is somewhat lower as a consequence. However, the producer's profit is gigantic compared to the first run—a fact which would spur manufacturers' interest in recycling programs, if future cash flows were not discounted with such a large interest rate.

It thus seems clear that recycling has all the advantages we have been expecting—both for consumer and producer, and both in the short and in the long run. What remains is to see how the recycling rate may be increased at an early point in the depletion of the natural resources. For this purpose we concentrate on the first 150 years of the second run on an extended time-axis (*above*), and this becomes the "standard run."



This run—the "standard" run—represents the real world, in that the recycling fraction is assumed to remain at its present value. Comparison with the "no-recycling" picture shows that even today's small amount of recycling makes a significant difference in the rate at which the material standard of living (that is, the number of products in use) declines. The same is true of the producers' profits.

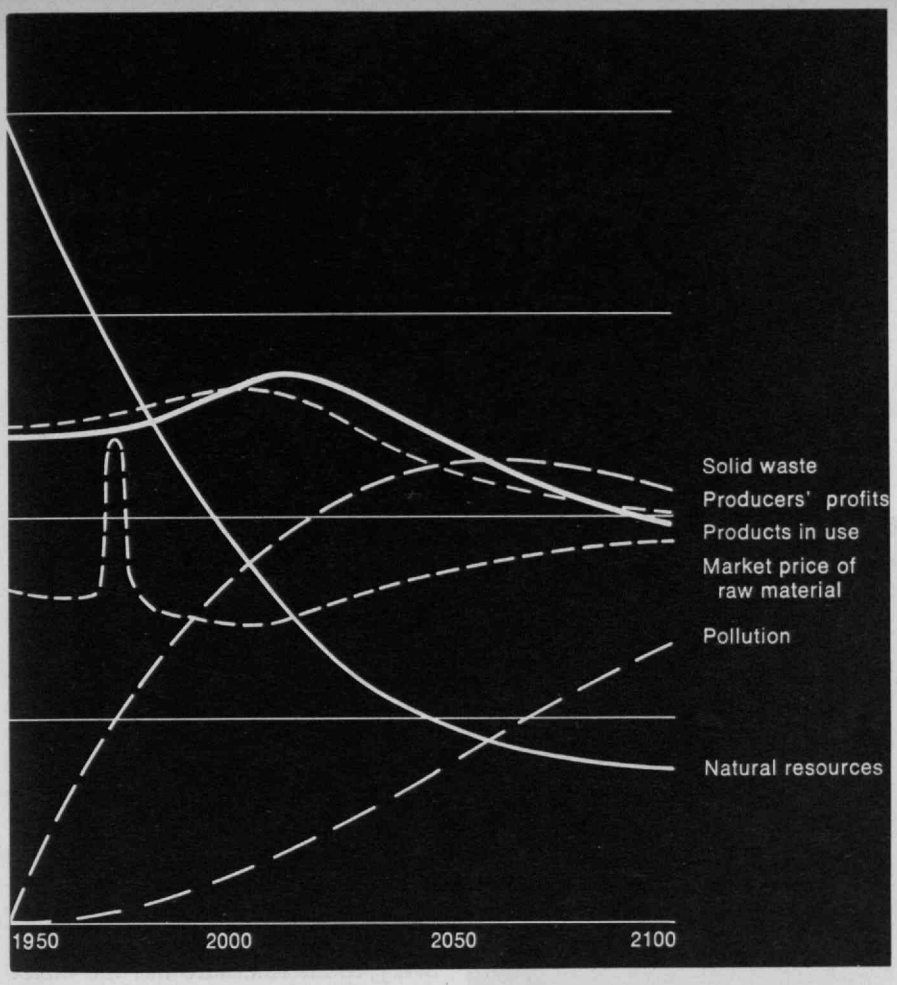
Tax vs. Subsidy

Numerous authorities have stressed the immediate importance of initiating or increasing recycling efforts, and there have been suggestions as to how one should go about it. Proposals have varied from subsidizing freight rates for trash to taxing the use of virgin material and using the income for research institutes on recycling. In principle, however, all the different proposals reduce to one question: Do we wish to enhance recycling by subsidies, or to discourage extraction by taxes? This model clarifies the implications of each approach.

As a first attempt at enhancing recycling, we introduced a 50 per cent tax on extraction (i.e., we increased the extraction cost by 50 per cent) in "1970." The effect was indeed to reduce the extraction rate and hence to save natural resources—but to a far smaller extent than one would expect; the system responded very quickly to the increase in market price of raw material by reduced demand, and the price was driven down again, nearly to its "non-tax" level. (The mechanisms which restored the market price to its former value were increased recycling and lower demand.) This is a good example of the unexpected ("counter-intuitive") results one generally experiences in complex systems. In fact, one can always anticipate that the system will compensate internally for changes imposed on it.

We conclude, therefore, that a tax on extraction would save some natural resources and would also reduce solid waste and pollution somewhat; but these would be achieved at the cost of a slight reduction in the number of products in use.

Next we studied the effect of reducing the cost of recycling by 50 per cent (simulating either a subsidy, a break-through in recycling technology, or a reduction in labor cost). The recycling rate increases significantly, resulting in an increased supply of raw material, lower prices, higher demand, and consequently a very large number of products in use. All this happened



This run shows one fairly successful policy, which combines a 50 per cent tax on the extraction of virgin copper with a 50 per cent subsidy for recycling, both introduced around "1970." The standard of living still declines, pollution still rises—but less rapidly, and the exhaustion of natural resources is appreciably retarded.

without increases in solid waste or pollution—in fact, the two were smaller than in the standard run. The producer's profit was very large. However, the natural resources were depleted nearly as fast as before.

To remedy this (and also to raise money to subsidize recycling), we tried combining the 50 per cent reduced recycling cost with a 50 per cent tax on mineral extraction. As hoped, the effect was to save natural resources, but there was also a reduction in the number of products in use due to a slight increase in the market price of raw materials (*above*). The solid waste and pollution were still lower than in the previous run, and since the number of products in use never fell much below the initial value, this solution was the best up to this point.

In the next run we simply assumed that products were built in a way that made them more easily recycled (an example being to make beer cans solely of aluminum, avoiding the aluminum-steel mixtures which result in difficulty for aluminum-recycling). The result was very similar to that obtained by subsidies.

Policies To Reduce Solid Waste

How can one reduce the solid-waste generation rate? As we mentioned at the start, there are three possible approaches:

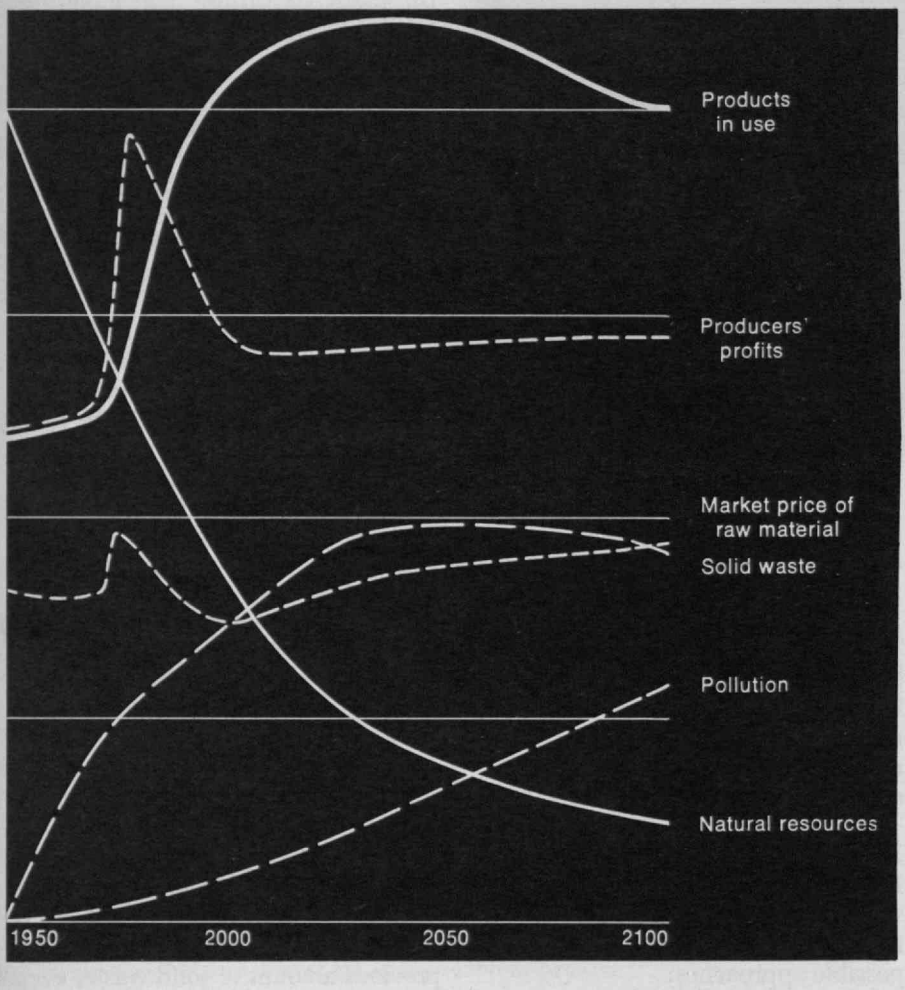
- ☐ Reduce the actual number of products in use.
- ☐ Increase the product lifetime.
- ☐ Reduce the amount of solid waste in each product.

An obvious—but politically infeasible—solution would be to tax the use of products so highly that people could not afford to use them (and the model confirmed that a 20 per cent tax on the market price of the product would indeed lead to a substantial decrease in the number of products in use and in solid waste—and would also make natural resources last much longer).

Other possibilities are more realistic. The second approach—increasing the product lifetime—could be pursued by better construction of the product, by ensuring that repairs were easy and inexpensive to perform, or (probably) by a reduction of labor cost relative to machine/energy costs. A run of the model clearly showed that this approach could substantially increase the "material standard of living" (i.e., the number of products in use). But the effects were complex: the longer lifetime would first reduce the yearly cost of using the product, resulting in higher demand and finally in a higher market price of the raw material. But this price increase was not large enough to make the yearly cost of using the product increase. The result was that the product lifetime, after its initial rise, started to fall back.

We then turned to the third approach—reducing the amount of raw material per product. We assumed that the reduction had no effect on product lifetime or on the market price of the product (simulating, really, a decision to eliminate some completely inessential part of the product, such as the packaging). The results were surprising, to say the least, when compared with the standard run. A reduction of the material in each product by 40 per cent led to no measurable reduction of the solid waste. The reason is simple, on reflection: The decrease in demand for the raw material which occurred when the producers reduced their use of it resulted in a substantial decrease in the market price for raw material, and this was reflected in the price of the product. The demand increased, and the resulting larger inventory of products in use was sufficient to produce the previous amount of solid waste, even with a smaller amount of waste in each product.

This demonstrates very clearly the deceptive behavior so often displayed by complex systems. It is this kind of behavior which is the *raison d'être* of the System Dynamics approach, which has been described by Jay W. Forrester elsewhere in this magazine (*see "Counterintuitive Behavior of Social Systems" in January, 1971, pp. 52-68*). It also explains why many well-intended laws and regulations have not worked out as planned.



How to beat the system. A policy is introduced, around 1970, which combines five measures each of which has been seen to be a partial solution: an extraction tax, a recycling subsidy (both 25 per cent), a 50 per cent increase in average product lifetime, a doubling of the recycling fraction, and a reduction in the amount of raw material per product. The last three measures are effected by an elegantly designed tax on products.

We tried the same basic strategy with a different assumption: that reducing the amount of raw material per product would affect both its market price and its lifetime. We investigated three possible relationships: the decrease in the product's lifetime is more than proportional to the decrease in raw material per product; it is exactly proportional; it is less than proportional.

Only the last of these cases gave any advantage over the standard run—and the advantage was only an increase in material standard of living. Quite contrary to our expectations, neither solid waste nor pollution decreased measurably. As before, demand increased, and in the end people simply had more to throw away. The other two possible cases gave worse results, so it seems that a reduction of the raw material in each product should be undertaken only if it leads to a less-than-proportional decrease in lifetime.

A Solution

From the runs just described, one could be tempted to draw the conclusion that nothing significant can be done about the natural-resource solid-waste problem—it seems that every countermeasure has the effect of increasing the solid-waste generation rate. Such pessimism is not justified. The adjacent diagram shows the results of a policy leading to a high material standard of living, low solid waste and pollution, and fair reserves of natural resources.

What kind of policy is it that has such advantageous effects? It is nothing but a combination of the policies we have already tried and found successful in certain respects. We combine:

- ☐ A 25 per cent tax on extraction.
- ☐ A 25 per cent subsidy to recycling.
- ☐ An increase in the product lifetime by 50 per cent.
- ☐ A doubling of the maximum recycling fraction.
- ☐ A reduction of the raw material per product, in such a way that there is a less-than-proportional decrease in product lifetime.

This example demonstrates that we can in fact reach the desired goals—if we bring about tremendous changes in the current system. It should be emphasized that many of the needed changes involve more than the development of new technology. They require changes in consumers' value judgments and in economic relationships.

From Theory to the Real World

The logical question is: How does one go about implementing these changes in the real world?

Taxing extraction and subsidizing recycling are straightforward policies which could be enacted in several ways. Increasing the maximum recycling fraction, reducing the amount of raw material per product, and at the same time increasing the product lifetime are more difficult.

One basic consideration: It is reasonable for the user of a product to bear the cost of disposal. Paying for disposal amounts to introducing the price mechanism into the "disposal market," so that a price is put on the consumption of scarce dumping grounds. This price of disposal would become the presently missing feedback between the solid waste generation rate and the consumer's high demand for products. However, it is important that this feedback is introduced in such a way as to represent an incentive to the producer to make products which create less trouble at the solid-waste stage. Thus, the feedback must lead to all the three advantageous, but difficult, changes mentioned in the last paragraph. Can such a feedback be found?

Luckily there exists one simple regulatory mechanism which would do all three things at the same time: a tax on products (ultimately paid by the consumer) which is proportional to the waste in the product divided by the product lifetime, w/L.

Remember that w is the amount of raw material, minus the amount that is recycled. Hence such a tax would be an incentive both to decrease the amount of raw material per product and to make the product in such a way that large parts of it could be recycled. By also making the tax inversely proportional to the product's lifetime, one could avoid the problem of the producer making his product so lightweight and flimsy that the lifetime falls more than proportionally. Indeed, the tax becomes an incentive to increase product lifetime by any method: by making better products, by making reusable products, by providing better repair services, or whatever can be devised.

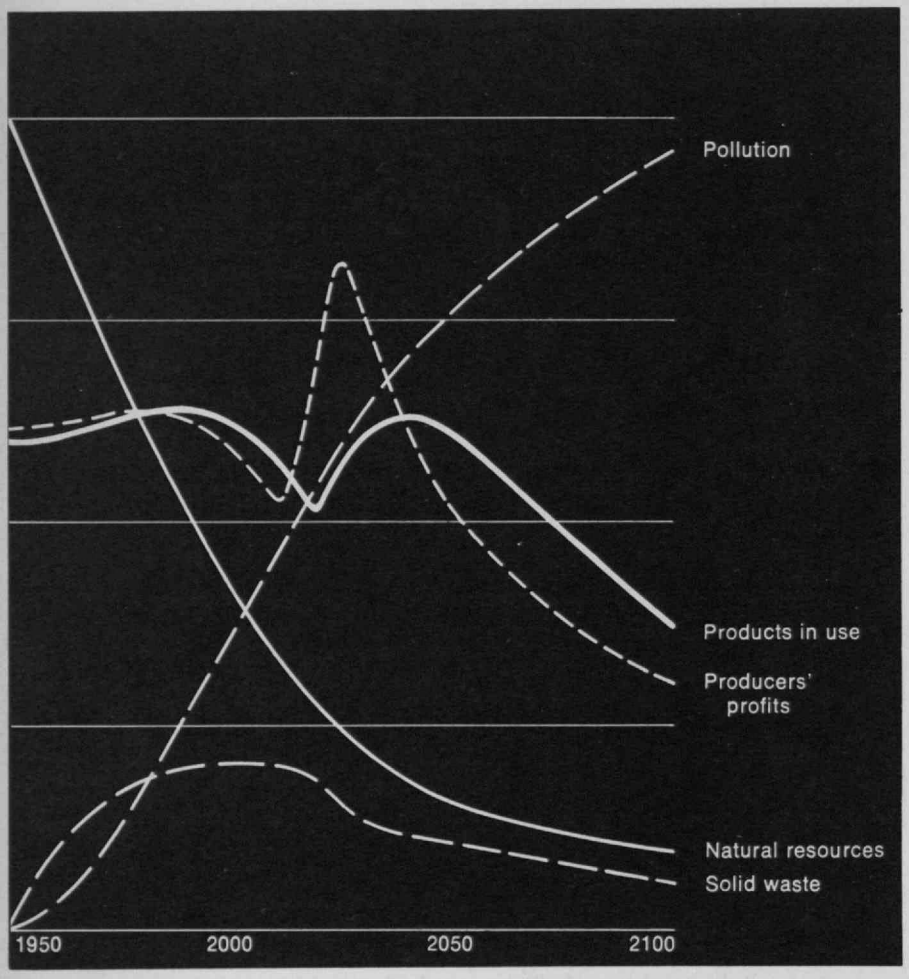
In practice, the lifetime of a product could be assessed from a statistical investigation by some bureau, which could also estimate the amount of raw material in the product and its amenability (in form or content) to recycling.

Although such a tax system might be among the most effective policies toward which we could move, many other directions can be suggested which would in fact be quite useful. The effects of most such alternative policies can be simulated by the solid-waste model. In order to study the effects of a specific policy, one must first determine what changes in the parameters of the model best represent the impact of that policy. The table indicates the changes in parameters which would simulate proposed policies.

As can be seen, all these policies ultimately influence the system by changing precisely the same parameters we have already tried changing. Thus, their relative effects can

Policy proposal	*Equivalent parameter change*
Remove depletion allowances in mining industries	Increase extraction cost
Remove deductions for cost of exploration	Increase extraction cost
Remove capital-gains tax treatment in mining industries	Increase extraction cost
Make freight rates as low for scrap as for virgin raw material	Decrease recycling cost
Remove federal stipulations that prohibit use of anything but virgin material	Decrease recycling cost (through the economies of scale which larger demand makes possible)
Make people sort their own wastes in their homes	Decrease recycling cost
Prohibit non-returnable containers	Increase product lifetime (for the substitute returnable containers)
Reduce packaging	Reduce raw material per product (without decreasing product lifetime)

A variety of measures have been proposed for solving the natural-resource/solid-waste problem. They can generally be expressed in terms of the parameters with which the authors' model deals. Thus, their effects can be assessed by examining the appropriate simulations.



The result of delaying the introduction of the five-point "beat-the-system" policy until the decline of resources begins to be seriously felt in the market—that is, around "2015"—renders the strong measures entirely ineffective. The same kinds of effects are produced, but on a scale too small to halt the decline in material prosperity.

be studied simply by reference to the simulation runs in which this specific parameter was changed.

The Urgency of the Problem

Given the modeling assumptions, the runs described above have all implied that we have something like 40 years to come to grips with the solid-waste problem— this is approximately the time, according to the standard (i.e. real-world) run, before the standard of living begins to decrease for lack of natural resources.

If we choose to postpone the implementation of well-chosen policies until the material standard of living has already started its decrease—that is, according to the standard run, until 45 years hence—the situation becomes much more critical. In the adjacent diagram are the results of a run in which we implement the "beat the system" policies in "2015" instead of in "1970." These very strong countermeasures then fail to have any significant effect. The long delays in our socio-economic system, combined with the inexorable depletion of virgin resources, mean that in order to avoid the decline, one must start changing policies many decades in advance.

Finally, the reader must not forget that all of the runs have assumed constant population and income per capita. In fact, both of these are growing exponentially, with an increase in the consumption of minerals of 2.5 per cent per year (for the past 100 years). This growth results in a 300 per cent increase in demand over a 40-year period and thus naturally increases the urgency of the necessary changes.

Suggested Reading

The approach to system behavior used in this article, System Dynamics, and the tools used to analyze the model have been developed at M.I.T. by Professor Jay W. Forrester and his group. Elements of the approach are contained in:

J. W. Forrester, *Principles of Systems*
J. W. Forrester, *Industrial Dynamics*
A. Pugh, *DYNAMO II User's Manual*

Major System Dynamics studies have been reported in, among other works:

J. W. Forrester, *Urban Dynamics*
H. R. Hamilton *et al., Systems Simulation for Regional Analysis*
D. L. Meadows, *Dynamics of Commodity Production Cycles*

The Apollo 16 Lunar Module will land on Cayley Plains, roughly half way between two bright, rayed craters (North Ray and South Ray). From there will be mounted three traverses—a short trip to Flag Crater and longer ones toward Stone Mountain and South Ray Crater and to Smoky Mountain. This landing site is in one of the "light-colored" highland areas presumed to be the oldest parts of the lunar surface. The contour interval on this map is 10 m., the horizontal scale about 1 km. = 1 in.

With Apollo 16 to Descartes

Never before in man's history has it been possible for more than a few people to witness major scientific discoveries. Here is a guide to an adventure in which millions will share.

Gene Simmons
Professor of Geophysics, M.I.T.

With Apollo 16 to Descartes

The Apollo 16 mission to the moon's surface is expected to be launched from Cape Kennedy on April 16 and to land a few days later in the Highlands region of the moon, near the crater Descartes. This landing site is extremely important from the viewpoint of lunar science. It will give astronauts their first chance to collect rocks in the lunar highlands, believed by some scientists to be the oldest regions on the moon, and also to study and collect new volcanic rocks; together with those already collected, the Apollo 16 specimens may provide the key with which to understand the early history of the moon, and they may also provide some new facts about the history of our solar system and of the earth.

Since the first manned lunar landing by Apollo 11 in July, 1969, significant improvements in both equipment and procedures have increased dramatically the capabilities of our astronauts. The total duration of the Apollo 16 mission is planned to be about 12½ days, with a maximum of 16 days. The Lunar Module (LM) is planned to remain on the lunar surface 73 hours, and of this time the astronauts will spend 21 hours in extravehicular activity (EVA).

Gene Simmons has worked on the Apollo program since 1965; he was for two years Chief Scientist of the Manned Spacecraft Center in Houston, and he is the principal investigator of an Apollo 17 experiment to measure the surface electrical properties of the moon. This article is developed from a guidebook prepared by Professor Simmons for distribution by the National Aeronautics and Space Administration; the book is available from the Superintendent of Documents, Washington, D.C., 20402, as number 3300-0421 @ $1.

Some 1,050 lbs. of scientific equipment will be used in lunar orbit, and 1,200 lbs. of such equipment will be landed on the lunar surface. The astronauts will have with them for the second time a small, four-wheeled vehicle for travel over the moon's surface, and before leaving lunar orbit they will deploy a subsatellite which will continue to serve us for many months—perhaps years—to come.

Scientific activities of the Apollo 16 mission will begin while the spacecraft is in orbit around the earth; these will consist mainly in photographing the earth with film sensitive to ultraviolet radiation. Ultraviolet photography will be continued during the journey to the moon, so that pictures are obtained at various distances from the earth; such photographs will help us interpret similar pictures of other planets.

During the journey to the moon one of the spent stages of the S-IVB rocket will be crashed into the moon so that the energy generated by its impact will travel through the moon to be detected by seismometers now operating at the Apollo 12, 14, and 15 sites. After the astronauts leave the moon, the lunar module (LM) will be similarly sent into the moon.

Though most interest will focus on the astronauts' activities on the lunar surface, the single astronaut who remains in orbit aboard the combined Command and Service Modules (CSM) will be responsible for many scientific experiments expected to yield data over a large part of both front and back sides of the moon.

The Landing Site

The Apollo 16 landing area, in the Descartes region, is situated in the southern highlands of the moon. Apollo 11, 12, and 14 visited mare—dark, smooth-looking areas as seen from earth. Apollo 15 landed just at the edge of a mare, and during their exploration its astronauts climbed part way up the slopes of the Apennine Mountains, a highland (light) area. Apollo 16 will visit a highland area, and its astronauts will be able to examine two different kinds of rock that together cover about 11½ per cent of the front side of the moon.

The Cayley Plains

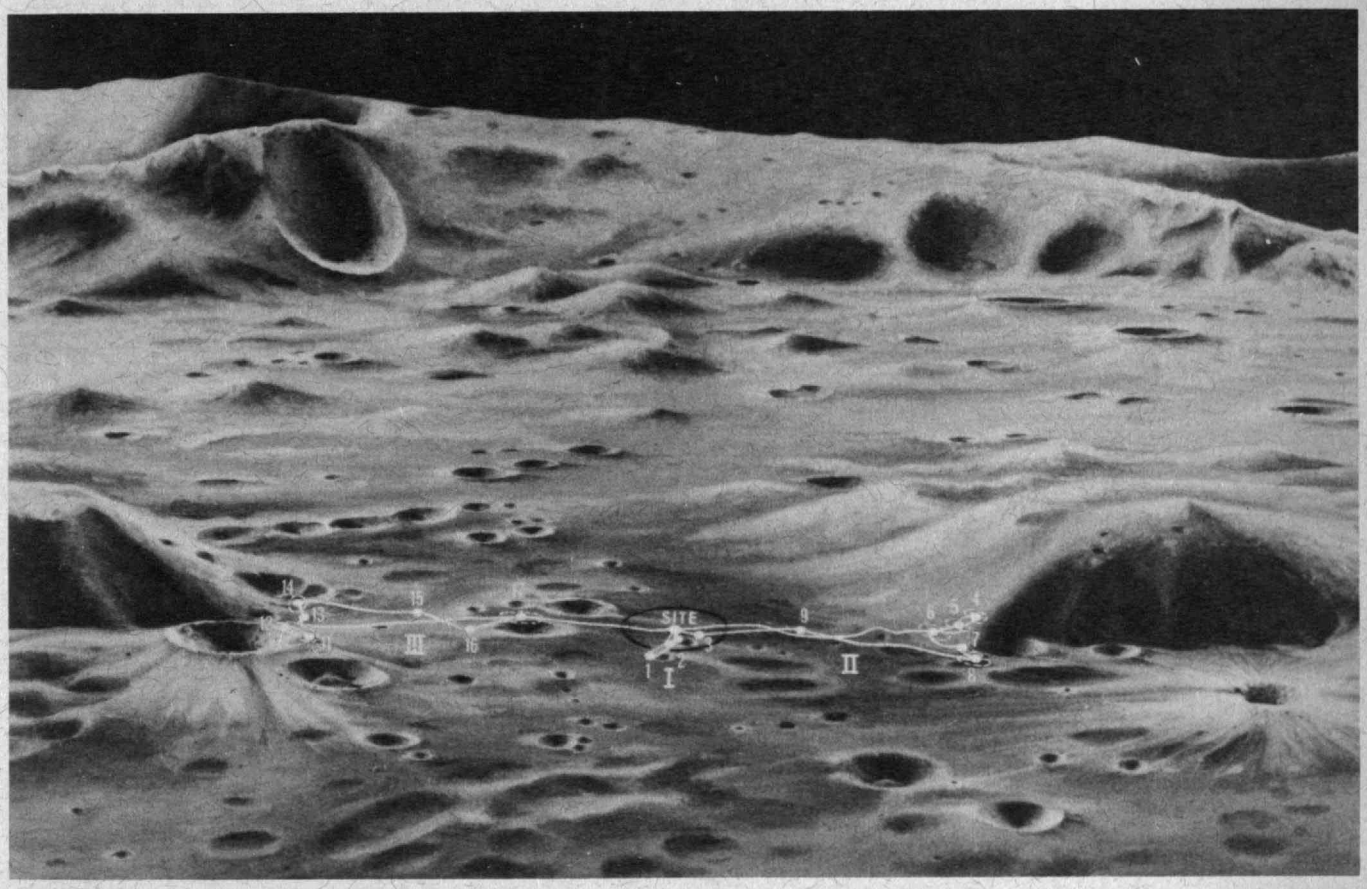
Between the two bright rayed craters (North Ray and South Ray) lies a rather smooth surface, the Cayley Plains, on which the LM will land. The rocks beneath the Cayley Plains are part of the largest single rock unit in the highlands of the front side of the moon, covering about 7 per cent of the surface.

The Apollo 16 landing site contains many craters, and the astronauts will visit a number of them, paying particular attention to collecting samples from various crater features.

We have studied on Earth how material is exhumed from depth by a large explosion; we have traced it through the air and seen it land along the path of the explosively driven material which forms a ray from the crater. The astronauts will collect rocks from such rays extending from craters near the landing site, and our information about terrestrial explosions will help us to interpret the history of the lunar samples.

The shapes of the craters themselves also yield information about the subsurface rocks. North Ray and the unnamed crater about one-half mile southeast of it have flat bottoms. The smaller craters at the landing

Apollo 16 astronauts will do more science than any previous lunar explorers. Here is a guide to the experiments and a summary of their importance.



The Apollo 16 landing area—in the so-called Descartes Region in the southern lunar highlands—is on a smooth section of the Cayley Plains. From the landing site three traverses will take the astronauts to the base of Stone Mountain to the south (right, above), and to the base of Smoky Mountain and the rim of North Ray Crater (left). (Drawing: Jerry Elmore from N.A.S.A.)

site, such as Flag, have cone-shaped bottoms. One interpretation of these features is that the large craters were limited in depth by a relatively solid layer which occurs below them. If such a layer exists, samples of it must surely be identified in the rocks brought back by Apollo 16.

The Descartes Formation

In contrast to the Cayley Plain, the Descartes Formation consists of highland plateau material which forms hills and valleys; it covers about 4½ per cent of the near side of the moon. The Descartes Formation is very likely composed of basalt; abundant samples should be available at the Apollo 16 landing site.

Surface Science Activities

The two astronauts will spend about 21 hours in three periods of seven hours each working on the lunar surface. Most of that time will be used to study geological features, collect and document samples of rocks and soil, and set up several experiments that will be left behind when the astronauts return to Earth.

Three surface traverses are planned using the Lunar Rover, as listed in the accompanying table. We know from previous Apollo missions that some minor changes in plans are likely to occur, but major changes are unlikely. Instructions to the astronauts have always been to "use their heads" in following detailed plans, and the Apollo 16 mission is no exception. The activities at each of the planned stops and

along each traverse between stops are shown in the table on pages 40 and 41.

Should the Rover become inoperative during the mission, the astronauts will substitute a series of walking traverses which have been planned. Mobility is limited, so these extend only three km. from the LM. One goes to the vicinity of Flag Crater, another towards Stone Mountain, and a third towards Palmetto Crater.

Lunar Surface Experiments

The astronauts will install the Apollo Lunar Surface Experiments Package (ALSEP) at a location at least 300 ft. from the LM. Four experiments will be connected electrically to the central station, which will receive 70 watts of electrical power generated by radioactive plutonium from the Radioisotope Thermoelectric Generator (RTG). All of the experiments together use approximately the amount of power required by an ordinary 75-watt light bulb.

Heat Flow Experiment

We are certain that the interior of the moon is warm—perhaps even hot and so we know that heat from the interior must be flowing to the surface where it is lost into cold space by radiation. The Heat Flow Experiment (HFE) will measure the amount of this heat flow at the Descartes site.

A similar measurement is now in progress at the Apollo 15 site, and many readers will recall the astronauts' problem of drilling the hole into which to insert the temperature sensors there. The problem was caused by the failure of the drill to expel the cuttings from the hole; the drill has now been redesigned, and it should make the Apollo 16 holes to full depth in 15 minutes, perhaps less.

Only in several months—perhaps more—will we have our best estimate of the amount of heat flow at the Apollo 15 site; the preliminary value is about one-half microcalorie/sq. cm./sec.—enough heat to melt a layer of ice 0.1 in. thick if the heat flowing through the surface is saved for an entire year. Yet this small amount is nevertheless about one-third of Earth's heat flow, which we know is responsible for much of the present surface configuration and for earthquakes and volcanoes as well.

The heat which is now flowing to the surface of the moon from the interior has been produced mostly by slow decay of the natural radioactive elements thorium, uranium, and potassium. Measurements made directly on the lunar samples returned by Apollo 11, 12, 14, and 15 have revealed significant amounts of these elements; indeed, the amounts are extraordinarily high. We know that these samples cannot be representative of the whole moon, because if they were the moon's interior would be molten throughout. Accurate knowledge of the amount of heat flowing from the interior of the moon will be used to set better limits on the amount of radioactivity now present in the moon, and we will then come closer to a correct understanding of its thermal history.

Passive Seismic Experiment

The Apollo 16 Passive Seismic Experiment (PSE) will join a network of similar experiments surviving from earlier Apollo flights to measure extremely small vibrations of the moon's surface. Some of these are caused by naturally occurring events, others by impacts on the moon of parts of spacecraft, still others by meteorites.

Two spacecraft impacts are planned for the Apollo 16 mission; the S-IVB will impact before the astronauts arrive and the LM after they leave. A very recent study of the results of previous spacecraft impacts has revealed the existence of a lunar crust that may be roughly 40 miles thick. Indeed, some of us now believe that the moon may in fact be shrouded with material which differs greatly from that in its interior. New data will come from the Apollo 16 impacts.

The data from natural events are also important to understanding the interior of the moon (*see "Unravelling the Lunar Layers" in* Technology Review *for February, p. 63*), and the seismic experiments also help us determine the number and size of meteorites that strike the lunar surface. We know from previous Apollo seismometers that the moon is still being bombarded by small objects, most of them microscopic in size.

Active Seismic Experiment

The Active Seismic Experiment (ASE) is complementary to the PSE in scale and source of energy; the PSE was designed to study the whole moon, the ASE to study the local landing site. The PSE will wait passively to receive vibrations on the moon, but the ASE will provide its own sources: two different kinds of explosions—small ones while the astronauts are on the surface and large ones after they have left the site. In the first case, a thumper will be used by an astronaut to explode 19 "shot-gun-like" charges; the larger explosions will come from a kind of mortar which contains four grenades to be launched with self-

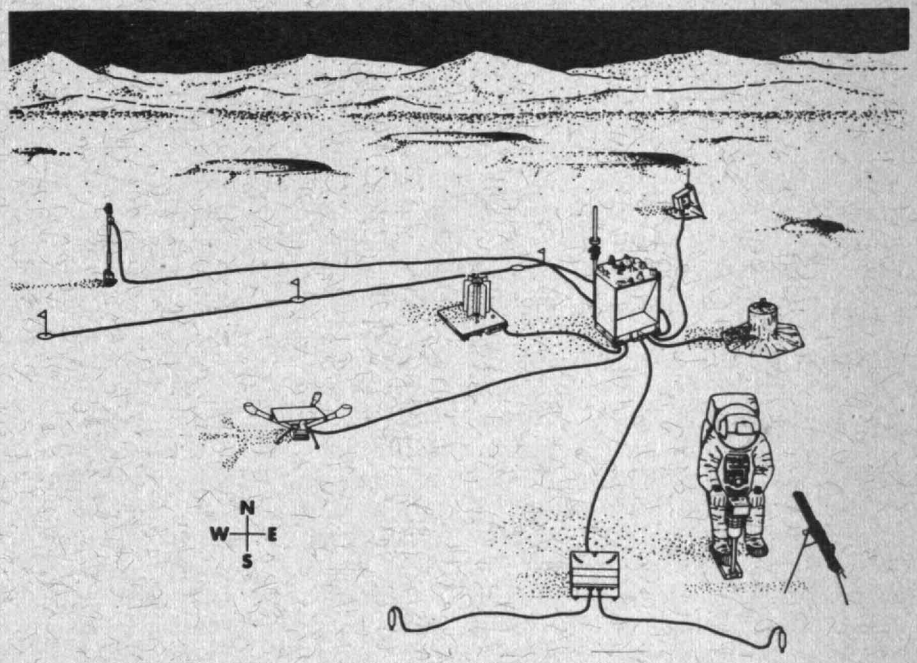
Apollo 16 will represent a dramatic increase in the capabilities of astronauts on the lunar surface; they will spend more than twice as much time there as any of their predecessors, and they will carry more than twice as much scientific equipment.

contained rockets. The astronauts will align the mortar launcher and arm it for firing, and the command to fire will be sent from the earth probably several months later.

Each grenade contains a rocket motor, a high explosive charge, provisions for igniting the rocket and a device to detonate the charge, a battery, a transmitter that provides information about the length of the flight and the moment of impact on the moon, and a thread with which to measure the distance of the impact from the launcher. Because there is (almost) no atmosphere on the moon, the thin thread which will trail the grenade will remain taut and measure accurately the horizontal distance from the point of launch to the point of impact.

The astronauts will deploy three geophones to "hear" the sound waves from the small explosions and transmit them over the ALSEP telemetry link to Earth, and the times at which the waves arrive at each of the three geophones, measured precisely, will indicate the velocity of sound waves in the lunar soil. If the depth to solid rock at the ALSEP site is not too great, then some of the energy will also be reflected from the rock back towards the surface to indicate the depth of the reflecting rocks.

The grenades which will produce the large explosions have been designed to impact the moon at distances of 450, 925, 2,800, and 4,500 ft. from the launcher. Any layering in the moon at the Descartes site in the first 1,000 ft. beneath the surface will be seen.



This drawing shows the general layout of the Apollo Lunar Surface Experiments Package as it will be deployed by the Apollo 16 astronauts at least 300 ft. west of the Lunar Module. Although the astronaut, equipment, and lunar features are drawn to different scales, their locations are shown in true relation to one another. The equipment shown is (from background to foreground) the Active Seismic Experiment, the Radioisotope Thermal Generator, the ALSEP Central Station, the Passive Seismometer, the Lunar Surface Magnetometer, and the Heat Flow Experiment; the astronaut is using the Lunar Surface Drill.

Surface Magnetometers

Two magnetometers will be used on Apollo 16. One, the Lunar Portable Magnetometer (LPM), will be carried by the astronauts to measure changes with distance of the moon's magnetic field. The other, the Lunar Surface Magnetometer (LSM), will measure variations with time of the magnetic field in one place on the lunar surface; similar instruments were left at the Apollo 12 and 15 sites, and they are still sending data to Earth.

The magnetic field of the moon (and also of the earth) has two parts, one that changes with time and one that is relatively steady. The steady part of the earth's field, the part which causes compass needles to orient themselves, is about 50,000 gamma. The steady part of the lunar field measured at the Apollo 12 site was about 35 gamma, and two measurements with smaller portable equipment at the Apollo 14 site revealed fields of 43 and 103 gamma. These figures are several times larger than we had expected, and the reason is not yet clear.

The steady part of the field is undoubtedly due to natural magnetism in lunar rocks, probably inherited early in the moon's history, and so a better understanding of it may contribute to our understanding of the moon's formation. On the other hand, the time-varying magnetic field on the moon is caused by propa-

The crew of Apollo 16

One of the faces and voices from Apollo 16 will be familiar to experienced space-watchers: Captain John W. Young, U.S.N., Apollo 16 Commander, has flown on Geminis 3 and 10 and Apollo 10. Other members of the Apollo 16 prime crew include Lieutenant Commander Thomas K. Mattingly II, U.S.N., Command Module Pilot, and Lieutenant Colonel Charles M. Duke, Jr., U.S.A.F., Lunar Module Pilot. Both are new comers to space flight; Commander Mattingly had the frustration of being replaced (because he was exposed to German measles) just before Apollo 13; Colonel Duke studied at M.I.T. as an Air Force officer in 1963 and 1964, receiving the S.M. degree after completing a thesis in the Department of Aeronautics and Astronautics on "Human Performance During a Simulated Apollo Mid-Course Navigation Sighting."

Back-up crewmen for Apollo 16 are Fred W. Haise, Jr., Commander; Lieutenant Colonel Stuart A. Roosa, U.S.A.F., Command Module Pilot; and Captain Edgar D. Mitchell, U.S.N. (M.I.T. Sc.D.'64) Lunar Module Pilot.

gating electromagnetic waves from the sun; and these variations, as measured at the surface of the moon, are greatly influenced by the electrical properties of its interior. So the study of surface variations over time will reveal electrical properties of the moon as a function of depth. Because the electrical properties of rocks are influenced by their temperature, we also hope to use the LSM data to measure indirectly temperatures in the interior of the moon.

Portable Magnetometer

The Lunar Portable Magnetometer (LPM) will be carried with the astronauts on their traverses and used to measure the moon's magnetic field at several different places. We expect that there will be a different value at each place, just as there would be on the earth, where variations of as much as several thousand gamma are common. However, because the moon's magnetic field is so much smaller, the magnetic anomalies must also be smaller.

An LPM was carried on the Apollo 14 mission, and—though only two measurements were obtained—the data were startling. The first, taken near the landing point, was about 43 gamma; the second, taken on a crater rim, was 103 gamma. We had expected neither such large values (we had an unequivocal indication that the *average* magnetic field at the surface of the moon could not be larger than 10 to 12 gamma) nor such a large change over a short distance. These changes with distance are almost surely caused by the natural magnetization of lunar rocks, and to help understand them we are anxious to obtain several measurements from Apollo 16.

The sensors for the LPM are contained in a box mounted on a tripod which during use must be set about 50 ft. from the Rover in order to isolate it sufficiently. The sensors must be oriented with the shadow of the sun and leveled; then the astronaut returns to the Rover, reads the three directional components of the magnetic field, and reports the readings to Earth. (The numbers he uses are not the values of the magnetic field; a calibration chart must be used to convert them.)

Solar Wind Experiment

The solar wind is the name given to the tenuous stream of matter, atoms of many chemical elements, which is ejected more or less continuously by the sun and spread throughout the solar system with a speed of a few hundred miles per second. The Solar Wind Composition Experiment (SWC), sponsored by the Swiss government, is designed to measure the composition of the solar wind as it strikes the surface of the moon.

The apparatus is essentially a sheet of aluminum foil like the familiar household item; exposed on the lunar surface, it will actually trap within it individual particles of the solar wind. The foil will be returned to Earth and the individual elements will be examined by the experimenters.

Cosmic Ray Detection

Cosmic rays are energetic particles—principally protons and alpha particles—which move through space at velocities almost the speed of light; they seem to originate outside our solar system, and they arrive from all directions. The equipment of the Cosmic Ray Detector Experiment (CRD) consists simply of plates of several materials carried on the outside of the LM to the moon; the passage of cosmic rays through the material is recorded as tiny tracks. Before departing from the moon the astronauts will recover the plates, which will later be examined on Earth to determine the particles which reached the LM and the directions whence they came.

Lunar Geology

Lunar geologists have as their goal the reading of the historical record of the moon for the past five billion years. That record has been preserved in the lunar rocks. At the Descartes site, we plan to study thoroughly two rock units, the Descartes and Cayley Formations. Both are widespread; the Cayley is the most extensive of all geologic formations in the lunar highlands.

Most of the astronauts' time during the three EVA's will be devoted to studying geologic features and to collecting samples of rocks from these two formations. These Apollo 16 samples will be studied by nearly 700 scientists all over the world. The minerals in them will be identified; their ages will be read from their built-in radioactive clocks; such physical properties as thermal expansion, velocity of sound waves, and electrical conductivity will be measured.

The value of all these measurements will be greatly increased by detailed knowledge of the original geologic setting of the rocks, and the astronauts will use several pieces of equipment to help with their tasks and with the later investigations on Earth.

On each previous Apollo mission, the astronauts have set about almost immediately upon emerging to gather a small sample of rock and soil—the contingency sample—which was stowed on board the LM.

The Apollo 16 astronauts will bring back from the moon several hundred pounds of rocks and soil never before exposed to the terrestrial environment—and one small sample of lunar rock which has made a round trip from moon to earth and back again.

Thus at least some material would come back if the mission had to be ended abruptly. We do not plan to collect such a sample on Apollo 16; instead, we expect to collect this sample only if it becomes apparent during the first EVA that the mission is likely to be aborted. The five minutes and one-lb. tool needed to collect the contingency sample are both very small, but we believe the new procedure will give the same insurance while giving us an additional five minutes to collect other, more valuable rocks.

A hammer will be available to drive core tubes into the soil, to break small pieces of rocks from larger ones, and in general for the things for which we use a hammer on earth. A scoop will be used to collect lunar soil and occasionally small rocks, and tongs will be available so the astronauts can collect small rocks while standing erect. As surface samples are collected they will be put in numbered Teflon bags—that material having been chosen because it contains no foreign compounds which might contaminate the samples.

A new kind of padded sample bag, about the size of the regular bag, is also being taken on Apollo 16. We hope that these bags will protect the very thin, fragile outer surface of some of the astronauts' rocks. The outer 0.01 in. of a rock is valuable for the study of its radiation history, evidence on the history of the sun and solar system.

A stainless steel container, the Special Environmental Sample Container (SESC), will be used to collect uncontaminated material. In this case we are particularly interested in biological contamination, the largest sources of which are the astronauts themselves; their suits leak many micro-organisms per minute, and the lunar rocks collected on previous missions have all contained a few parts per billion of organic material. Whether any of this was present on the moon before the landings is still uncertain.

Several other tools will be used to collect samples. Drive tubes will be used to collect core material to depths of up to four feet; the cores will remain in the tubes for return to Earth. Because marble-sized rocks from the moon have proven to be especially valuable, we have designed a "rake" to collect them. The Apollo Lunar Surface Drill (ALSD), used for the HFE, will also be used to drill a third hole through soil and small rocks, from which the samples will be saved. Because the astronaut cannot easily bend over to reach the lunar surface in his space suit, an extension handle will be available for most tools.

One small piece of lunar rock from an earlier Apollo mission will be carried back to the moon on Apollo 16; it will be re-exposed to the lunar magnetic field and then returned once more to earth. This is because we are having some difficulty in understanding the permanent magnetism in the lunar rocks. One part of that magnetism is very delicate, and we are not yet sure just how, or when, the rocks obtain that part. We will remove the delicate part of the magnetism in the sample rock before its return journey, and when the rock is back again on Earth we will see whether that delicate magnetism has been restored on the moon.

The Hasselblad cameras used by the astronauts were made especially for the Apollo missions. They use 70-mm. film, either color film similar in characteristics to Ektachrome-EF (daylight type) or black-and-white film with characteristics like Plus-X.

The primary purpose of the cameras is to document the astronauts' observations and especially the rocks they collect. Ideally, several photographs will be taken of each rock: before collection with the sun behind the astronaut's back, before collection with the sun to his side, another to provide a stereo pair, after collection so we can see clearly where the sample was collected, and a final one to show the general location.

Still more documentation will be desirable at some stations. Panoramic views will be made frequently, and the overlapped regions of these series will be used for stereoscopic viewing.

It is in these activities that the special training of the astronauts in lunar science will pay dividends. Anyone can pick up rocks with which to fill boxes and bags; but only a person highly trained in the geosciences can properly select those few rocks, from many, that are likely to yield the greatest scientific return when later examined in minute detail.

The First Lunar Astronomy

The Lunar Surface Ultraviolet Camera-Spectrograph (UVC) to be used by the Apollo 16 astronauts will provide the first astronomical observations made from the moon. With it, we hope to study the earth's upper atmosphere, the magnetosphere, and their interaction with the solar wind; the interstellar gas present throughout "empty" space; and the ultraviolet haloes of galaxies. By pointing the camera toward the lunar horizon, we should detect volcanic gas if any is present near the

This schedule of activities during the three traverses planned for Apollo 16 should be considered a general guide only; the times are likely to change during the mission, and not every item listed is mandatory at each stop.

Station	Elapsed time when activity starts	Amount of time assigned to activity	Activities and observations
EVA I			
Cayley Plains	—	1:37	Egress Lunar Module, deploy Lunar Rover
Cayley Plains	1:37	2:24	Deploy Apollo Lunar Surface Experiments Package
Travel	4:01	:14	Across Cayley Plains and rays; observe distribution of ray material
Flag Crater (station 1)	4:15	:30	Explore Flag Crater and excavated Cayley material; take panoramic photographs; sample crater materials; use rake to take rock sample; make Portable Magnetometer measurement
Travel	4:45	:06	Across Cayley Plains to Spook Crater
Spook Crater (station 2)	4:51	:31	Inspect and describe geology, dividing time between Spook and Blocky Craters; take panoramic photographs; take 500-mm. photographs of outlying areas; take documented sample
Travel	5:22	:08	Across Cayley Plains, crossing the EVA II route to Stone Mountain; observe and describe ray patterns
Cayley Plains (station 3)	5:30	:50	Use rake to take rock sample; use double core tube; take documented sample; make trench and penetrometer soil mechanics measurements; take soil sample from trench; retrieve 2.6 m. core
Lunar Module	6:20	:40	Return to Lunar Module; store samples; ingress
EVA II			
Cayley Plains		:50	Egress Lunar Module; prepare for EVA
Travel	:50	:10	Observe and describe distribution of rays, abundance of blocks, etc.
Cayley Plains near South Ray (station 4)	1:00	:15	Examine and describe area; take documented samples, including surface and shallow trench soil samples
Travel	1:15	:19	Across Cayley Plains to base of Stone Mountain; observe and describe Stone Mountain, noting its slope
Stone Mountain (station 5)	1:34	:30	Note and describe Descartes Formation and local geology; take panoramic photographs; take documented samples; take elongated single core
Travel	2:04	:09	Through Descartes Formation
Stone Mountain (station 6—the highest point reached on Stone Mountain)	2:13	1:00	Observe and sample Descartes Formation; take panoramic photographs; take documented sample, including sample with rake; take double or triple core; take Portable Magnetometer measurement; take 500-mm. photographs; use penetrometer
Travel	3:13	:02	Through Descartes Formation
Stone Mountain (station 7)	3:15	:45	In cratered and terraced region of Descartes Formation; take panoramic photographs; take documented sample; take 500-mm. photographs of South Ray Crater
Travel	4:00	:12	Through Descartes Formation

continued next column

Descartes site. And finally, with the UVC we will evaluate the moon as a possible site for future astronomical observations.

The UVC camera will be used in two different ways—to make direct images and—in connection with a spectrographic grating—to record the ultraviolet components in the light source. In operation, the astronaut will set up the camera, level it, and point it toward the target to be photographed. Its operation will then be automatic so that the astronaut can proceed with other work, returning later to retrieve the exposed film.

Soil Mechanics

The Apollo 16 program includes observations of the mechanical properties of the lunar surface—the dust raised by the descending LM, that thrown up by the wheels of the Rover, and that which the astronauts encounter in walking. In addition, the astronauts will carry a self-recording penetrometer with which to occasionally measure the bearing strength of the soil.

Science in the Service Module

In comparison with the total area of the moon, the regions explored by astronauts are miniscule; they are frequently referred to as "point" samples. We are of course anxious to extend our observations to larger areas, and this is the assignment of the astronaut who remains in the CSM.

Almost all of the orbital experiments will be done with equipment in the service module's Scientific Instrument Module (SIM). This will include a group of three chemical instruments (gamma-ray spectrometer, x-ray fluorescence meter, and alpha-particle spectrometer), S-band trans-

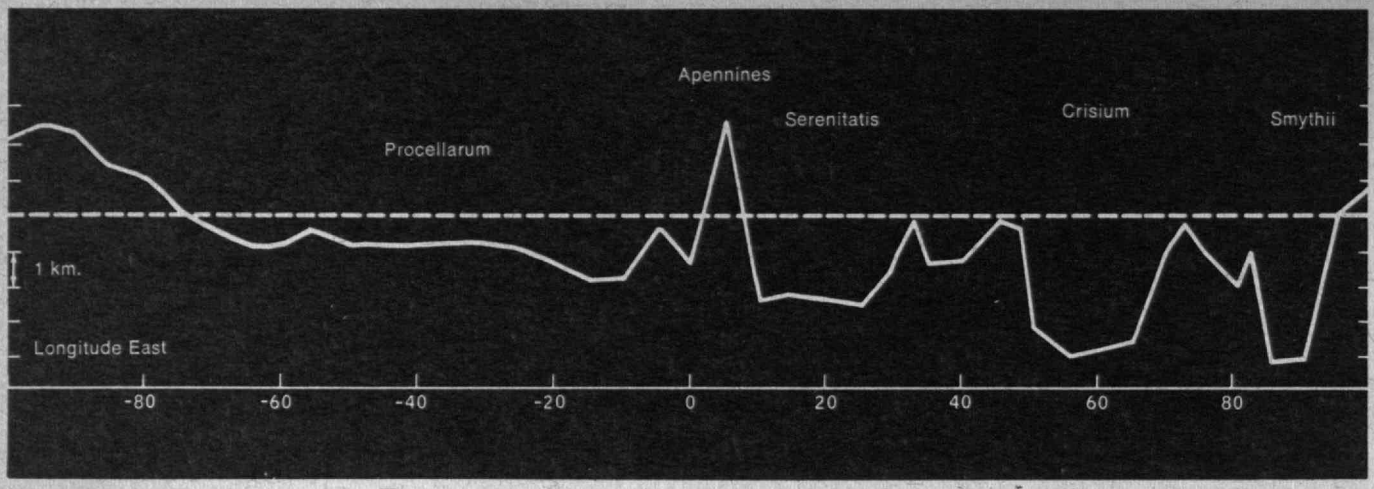
Station	Elapsed time when activity starts	Amount of time assigned to activity	Activities and observations
EVA II (continued)			
Stubby Crater (station 8)	4:12	:20	Take panoramic photographs; take documented samples of Stubby Crater rim; take 500-mm. photographs of south wall of Stubby Crater
Travel	4:32	:07	Across Cayley Plains
Rays from South Ray Crater (station 9)	4:39	:55	Take panoramic photographs; take double or single core; take documented samples, including sample with rake, use of padded bags, and boulder samples
Travel	6:07	:12	Across Cayley Plains
Lunar Module	6:19	:40	Return to Lunar Module; store samples; ingress
EVA III			
Cayley Plains		:45	Egress Lunar Module; prepare for EVA
Travel	:45	:22	Across Cayley Plains toward North Ray
Dot Crater (station 11)	1:07	:10	Take soil and rock samples; take Portable Magnetometer measurement
Travel	1:17	:15	Toward outer ejecta blanket of North Ray Crater
North Ray Crater ejecta blanket (station 12)	1:32	:10	Take rock and soil samples
Travel	1:42	:03	To rim of North Ray Crater
North Ray Crater (station 13)	1:45	:56	Take stereo panoramic photographs; take 500-mm. photographs of crater rim and interior; take documented sample
Travel	2:34	:05	Around the rim of North Ray Crater
North Ray Crater (station 14)	2:46	1:05	Take panoramic photographs of block field; take 500-mm. photographs of North Ray Crater interior; take documented sample of boulder; use rake to take rock and soil sample
Travel	3:51	:14	From North Ray Crater to the base of Smoky Mountain, through the Descartes Formation; describe the transition to Smoky Mountain
Smoky Mountain (station 15)	4:05	:40	Take panoramic photographs; take documented sample of Smoky Mountain; take double core sample; take 500-mm. photographs of Smoky Mountain; use rake to take rock and soil sample
Travel	4:45	:21	Across Cayley Plains to Palmetto Crater
Palmetto Crater (station 16)	5:06	:36	Take panoramic photographs; take documented sample of Palmetto Crater rim; use rake for rock sample; take Portable Magnetometer reading
Travel	5:42	:08	Across Cayley Plains
Cayley Plains (station 17)	5:50	:10	Take documented sample of soil and rock; take Portable Magnetometer reading
Travel	6:00	:09	Across Cayley Plains toward Lunar Module
Lunar Module	6:09	:50	Return to Lunar Module; store samples; close out; ingress

ponder, mass spectrometer, several photographic cameras, and a laser altimeter; there is also a subsatellite with S-band transponder, particle plasma experiment, and magnetometer that will be left in lunar orbit.

Orbital Science Activities

The initial lunar orbit will be an ellipse with maximum distance from the moon of 170 nautical miles and minimum distance of 60 nautical miles. A few hours after this orbit is achieved the spacecraft will be placed into a 60-x-8-nautical-mile orbit from which the LM will descend to the moon some 17½ hours later. During this 17½-hour period the SIM experiments and cameras will scan the lunar surface and the S-band transponder experiment will be performed. Later, as the LM is touching down, the CSM's orbit will be circularized at 60 nautical miles, and during the next three days, while the LM remains on the surface of the moon, all of the orbital experiments will be performed from this orbit. Some 20 hours after the LM lifts off the moon the CSM orbit will be changed again, to increase the coverage of the moon's surface by its orbital experiments; and once more, several hours before leaving lunar orbit for return to earth, the CSM orbit will be changed to provide maximum lifetime for the subsatellite which will be then ejected from the SIM.

The orbit of the subsatellite has been carefully designed to provide a one-year lifetime and to place the subsatellite near the lunar surface. It will change slowly with time, and that spacecraft will eventually hit the moon. But we hope it will remain in orbit for at least one year, and if we are lucky it may survive considerably longer.



The laser altimeter used from the Command and Service Module of Apollo 16 will be identical with that which obtained this record of lunar surface elevations during the Apollo 15 mission. This chart shows the elevation of the lunar surface under a single Apollo 15 orbit; the dashed line represents the elevation of a sphere with a radius of 1,737 km.

Orbital Photography

A 24-in. panoramic camera in the SIM will be used to obtain high-resolution photographs with both stereoscopic and regular monoscopic coverage of the moon's surface. When in use the camera will rotate continuously across the path of the orbiting CSM to provide the panoramic scanning, and it will also automatically tilt forward and backward to provide stereo coverage. In addition, in order to prevent blurring of the image, the camera will automatically compensate for the forward motion of the spacecraft. And finally, one sensor on the camera will detect and automatically correct for the ratio of the forward velocity to the height of the spacecraft above the moon's surface.

From an orbital altitude of 60 miles this camera will provide an image with three- to six-foot resolution of the moon's surface. A low-speed black-and-white aerial-type film will be used, and the cassette must be retrieved by an astronaut, normally the CM pilot, during an EVA in space.

A second mapping camera, really two cameras in a single assembly, will make photographs of the lunar surface through a three-inch cartographic lens and photographs of the star-field through a three-inch stellar lens; thus it will record the exact location whenever a photograph is made. Our purpose with this camera will be to locate very precisely the surface features of the moon; it will use an intermediate-speed black-and-white aerial film.

The Laser Altimeter

The laser altimeter, operating much as a radar does, will obtain the elevation of the CSM from the lunar surface with a resolution of about three feet. Because the orbit of the spacecraft will be monitored continuously by tracking stations on the earth, the position of the spacecraft will be known with rather high precision. By subtraction we will learn the elevation of the lunar surface.

A similar experiment on the Apollo 15 flight yielded very exciting results, showing that the center of mass of the moon is displaced about 1½ miles from the center of volume in a direction approximately midway between the locations of the two largest gravity anomalies on the front side of the moon.

The Chemical Experiments

Three experiments, known as the chemical group, will be used on the CSM to obtain data sensitive to the composition of the moon's surface in the area immediately below the orbiting spacecraft.

X-Ray Fluorescence

X-ray fluorescence is one of the standard techniques for identifying an unknown substance. Incident x-rays knock electrons out of their normal positions in the material, and when the electrons return they emit x-rays with characteristic wavelengths and energies. Thus x-ray emissions from the lunar surface result from the x-ray bombardment it constantly receives from the sun. The X-Ray Fluorescence Experiment (XFE) will measure this radiation; because there is almost no lunar atmosphere the fluorescent x-rays can be observed at the CSM in orbit at an altitude of 60 miles.

Under favorable conditions, we expect this experiment to detect and measure the amounts of magnesium, aluminum, and silicon in the surface materials of the moon.

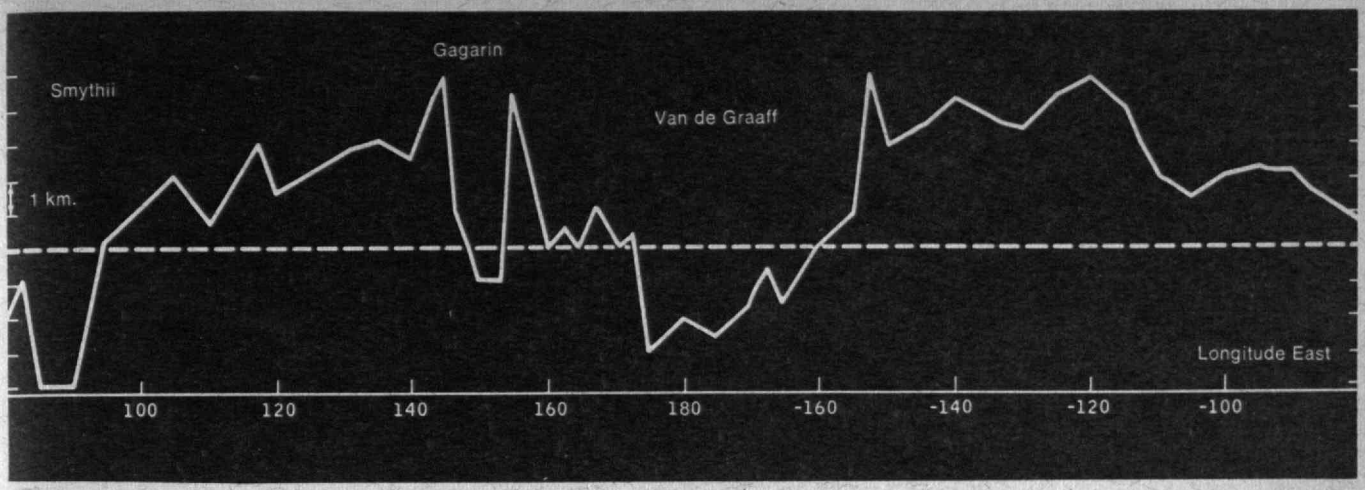
Alpha-Particle Spectrometry

The distribution of alpha particles—helium ions—over the surface of the moon will be studied by the Alpha-Particle Spectrometer (APS) in the SIM. Analysis of both rock and soil brought from the moon reveal that uranium and thorium are present in extremely small—but significant—amounts. Both are radioactive, and radon, a radioactive gas, is one of the intermediate products of their decay.

Released underground, radon diffuses through the lunar soil and cracks in rocks to reach the lunar surface. Since there is no atmosphere, it then follows a ballistic trajectory above the surface, returning to some distant point. When radon decays it produces alpha particles, and it is the energy of these which will be measured by the APS. The point, of course, is to determine the spatial variation of the present radioactivity of the moon.

Gamma-Ray Spectrometry

Because gamma rays with certain energy and wavelengths are characteristic of the radioactive decay of certain kinds of rocks, we may infer the composition of the moon's surface from measurements of gamma-ray emission. Thus the chief purpose of the Apollo 16 Gamma-Ray Spectrometer Experiment (GRS) is to map the distribution of certain kinds of rocks over the lunar surface.



A gamma-ray spectrometer similar in all respects to the Apollo 16 equipment was flown on Apollo 15, but the final results of that experiment are not yet available. We expect the results to correlate with the geological features of the moon and that Apollo 16 data will add new dimensions.

Mass Spectrometry

The Mass Spectrometer Experiment (MSE) is planned to measure the composition and density of gas molecules along the flight path of the CSM. The moon's atmosphere is extremely thin; we expect to find only small quantities of such light gases as hydrogen, helium, and neon—with neon probably ten times as abundant as the others—from the solar wind and argon from the decay of radioactive potassium. Certain other gases, such as carbon dioxide, carbon monoxide, hydrogen sulfide, ammonia, sulfur dioxide, and water vapor, may have been produced by lunar volcanoes.

About 40 hours of mass spectrometer data were obtained in lunar orbit by Apollo 15, and about 50 hours were obtained during Apollo 15's travel between the earth and moon. Many gases were clearly present; though the data have not all been analyzed, it seems that rather significant amounts were in orbit around the moon.

S-Band Transponder

With the S-Band Transponder (SBT) we hope to measure very small variations in the moon's gravity; these are the anomalies which have led to postulations of mascons beneath the lunar surface. As the spacecraft approaches such a denser area of the moon, there is a gentle tug in the forward direction; as it leaves the area there is a corresponding decrease in orbital velocity. High-precision measurements of these velocity changes are obtained by measuring the Doppler shift as seen on earth of a radio wave transmitted from the earth and returned through a frequency-multiplier from the CSM.

The first data on such gravity variations came from the Lunar Orbiter series, and their discovery by Paul Mueller and William Sjogren of the Jet Propulsion Laboratory ranks as one of the most important scientific findings about the moon. On Apollo 16, the S-band transponder experiment will obtain data from three spacecraft—the orbiting CSM, the LM, and the subsatellite. Because the subsatellite will stay in lunar orbit for many months, it will add substantially to our store of data and may show whether there are large variations in density beneath such features as the large craters.

Bistatic Radar

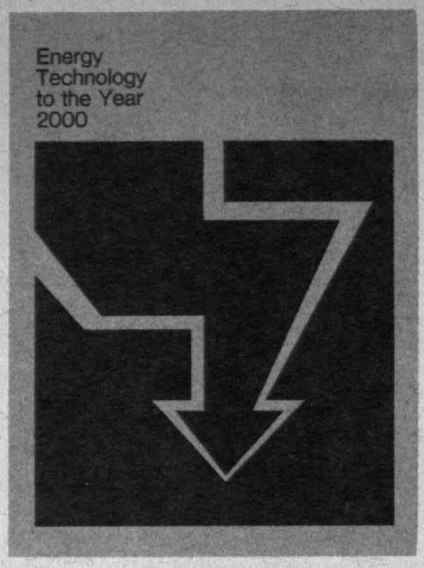
Even in space exploration, one sometimes gets something for (almost) nothing. Such is the case with the Bistatic Radar Investigation (BRI). In this experiment, we will study the radio signal normally used in communications between the CSM and earth, comparing the signal transmitted directly to earth with that reflected to earth from the moon's surface. The comparison will tell the electrical properties of the outer few yards of the moon's crust at the point of reflection, the average slope of the moon's surface at that point, and if rocks are buried under it to depths of several feet.

The Subsatellite Experiment

The scientific value of the Apollo 16 flight will be enhanced by the 85-lb. scientific spacecraft that will be left in orbit around the moon when the astronauts return to earth. The subsatellite will carry two experiments, one to measure plasma and solar particles and the other to measure magnetic fields. It will also carry solar cells that deliver 24 watts, solar sensors (to let us know the direction in which the satellite is pointing), a battery-pack of silver-cadmium cells (for power when the satellite is in the shadow of the moon), a data storage unit, and an S-band communications system.

The chief objectives of the plasma and solar particles experiment are to describe the plasmas through which the moon moves, to measure the moon's interaction with these particles, and to study the structure of the earth's magnetosphere. These things will be done by an instrument which will measure the direction and energy of the charged particles —either electrons or protons— which it encounters.

The orbiting magnetometer will provide measurements of the changes with time of the magnetic field in space. One of the surprises in the Apollo science program has been the discovery that the magnetic field at the surface of the moon is much larger than we had predicted and that it is significantly different at different locations. A preliminary examination of data from the Apollo 15 subsatellite from the far side of the moon suggests that the very large craters, those over 60 miles across, have permanent magnetic fields associated with them. If this preliminary result is confirmed, it will be another in the remarkable series of scientific achievements of the Apollo program.



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The Aqueous Underground

There is far more usable water under the ground than on the surface. As we increase our demands on underground sources, our need for fundamental knowledge as well as understanding of many local geologic details will become apparent. So, too, will our need for sensitive, sensible regulation.

Over 98 per cent of all the fresh liquid water on the earth is hidden beneath the surface, within the pores of rocks and granular materials. The remaining two per cent is what we see in lakes, rivers, and reservoirs, with man-made reservoirs accounting for around one per cent of this surface water. Of the fresh water below the surface, about 98 per cent satisfies the description of "ground water"—that is, water which occurs in saturated materials below the water table. The remaining two per cent is soil moisture, in the unsaturated zone above the water table; it is essential for plant growth.

The total world resource of liquid fresh water is estimated to be somewhat above 7 million cu. km.

The vast reservoir of water beneath the surface of the earth plays an essential role in the natural circulation of water which sustains the flow in many rivers. Rain and snow are so unevenly distributed, in time and geographically, that even large rivers would dry up without this so-called "base flow." The role of ground water is illustrated by the flow chart on the next page, which represents the hydrologic cycle in terms of average global conditions.

The implied average time for a drop of water to travel through the ground-water system, from rainfall to the sea, is somewhat over 400 years. As with any global average, local variations of a few orders of magnitude either way are possible, but this figure does illustrate the great disparity in time-scale between ground- and surface-water systems. For example, even if all of the river flow passed through lakes (which store and retard it), an average travel time of ten years would be reasonable for the surface system; more realistically, if only the river-channel storage is considered, the average surface travel time is on the order of weeks.

Man's use of this vast underground water resource is very limited in relation to what is available. Ground water from springs and shallow wells has always been an important and reliable source of water in arid regions where surface sources are erratic or nonexistent. In ancient times there were some well-organized efforts to develop ground-water supplies, notably the tunnel systems found on the Iranian Plateau. These tunnels, called *qanats*, were developed to intercept the ground water in alluvial deposits at the base of mountains and carry it to towns and fields. Some of the tunnels, many of which were constructed several centuries B.C., extend for many miles, several hundred feet below the surface. They still supply 75 per cent of the water used in Iran.

Ground water is the primary source of water for domestic use in rural areas, and in some regions it is used intensively for industrial, agricultural and municipal supplies. But modern water supply development, especially in metropolitan areas, has concentrated on the more limited surface sources. This seeming disparity is due to a number of factors ranging from public misconceptions about ground water to serious economic, technical, scientific, and legal limitations; but it is largely traceable to our relative ignorance concerning the occurrence and movement of subsurface water.

Lynn W. Gelhar has been a member of the M.I.T. faculty since completing undergraduate and graduate study in the Department of Civil Engineering at the University of Wisconsin in 1964; his research and teaching are in the fields of turbulent flow and fluid mechanics, and he has recently applied this fundamental research to ground-water studies such as he reports in this article.

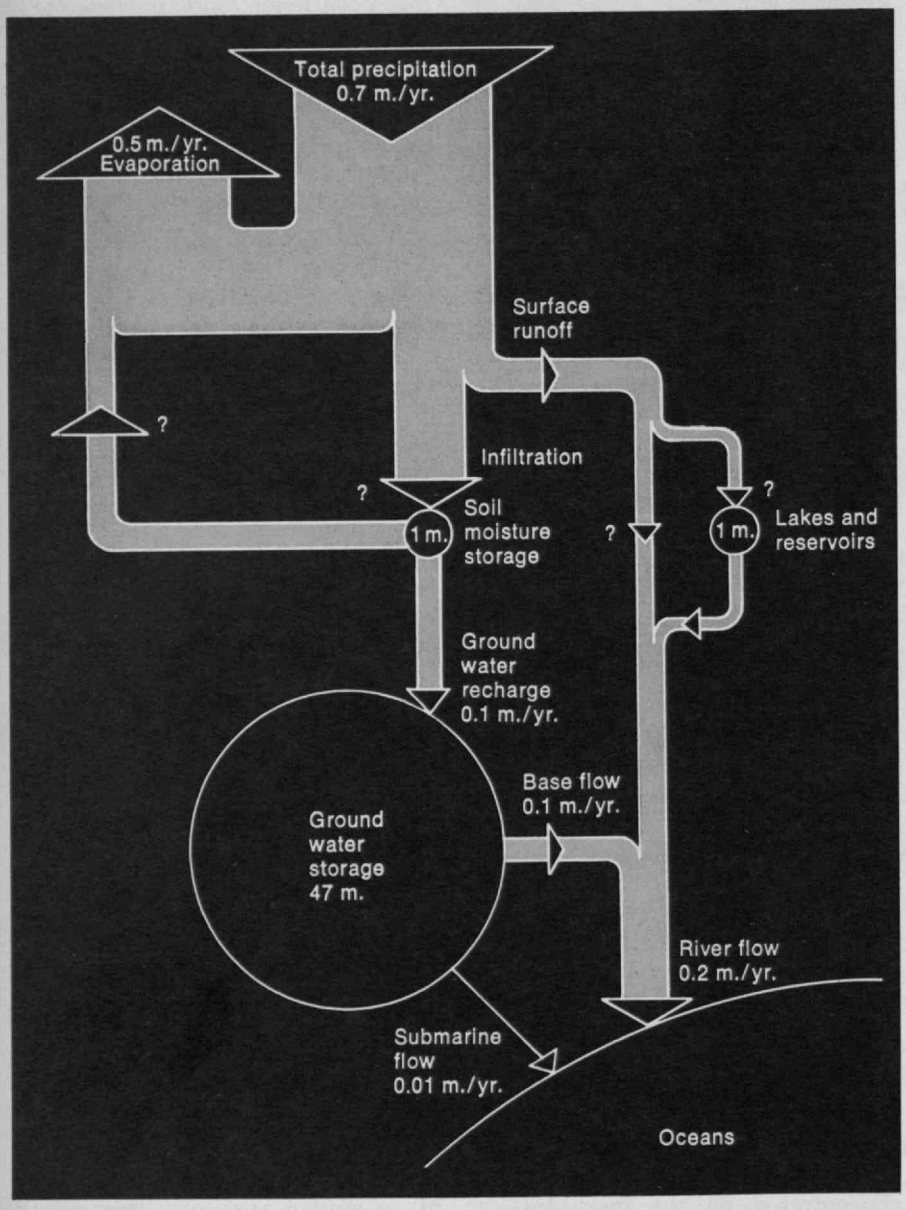
High Quality, Slow Motion

Practically all subsurface fresh water originates as rain. Some of this rainfall infiltrates into the soil, where a portion of it may be captured by roots to sustain plant growth; the rest percolates down to a zone which is saturated, whose upper surface is the water table. This general process we call "ground-water recharge."

Ground water occurs in a variety of materials, including unconsolidated granular materials such as glacial or alluvial deposits of sand and gravel and sedimentary rocks such as sandstone and limestone. The water storage capacity of a material is indicated by the porosity—the proportion of the medium's volume not occupied by solids; this is typically 25 per cent for sand and gravel. A more important characteristic of a water-bearing material is the ease with which water can pass through it—the permeability.

As a result of the way in which the materials were originally deposited, aquifer systems are usually far from uniform in their hydraulic properties. Sedimentary deposits often consist of parallel layers of different materials such as limestone, sandstone, and shale or (in the case of unconsolidated deposits) sand, gravel, silt, and clay. Within a given layer the permeability may vary significantly along the layer. Thus, even when the geologic structure of an aquifer system is known, the details of water movement within it are difficult to deduce.

But the general process of ground-water movement is very simple—it is a gravity-driven motion resisted by fluid friction in the porous medium. The typical topography of the water



The hydrologic cycle of the earth includes all the fresh water visible in lakes, ponds, and rivers, the moisture used by growing plants in the upper layers of the soil, and the invisible water which collects in the deeper layers of the soil and rocks. But 96 per cent of all the liquid fresh water is the latter—ground water. This drawing shows a portion of the hydrologic cycle for average global conditions on land, with the rates of flow and amounts of storage indicated by the widths of flow lines and areas of circles, respectively. Quantities, in meters depth averaged over the land surface, are based on data given by R. L. Nace, except that groundwater flow is estimated to be half of the total river flow.

table is a subdued form of the surface topography, and a general circulation pattern develops which is analogous to the streams and lakes of the surface world: recharge and downward flow at the higher elevations and an upwelling of water at the lower elevations where it is discharged to springs, marshes, and stream channels. The scale of this circulation pattern may range from hundreds of feet to tens or hundreds of miles. The larger-scale features usually involve deeper and slower circulation. The rate of water movement ranges from a few feet per year to a few feet per day, and transit times through a flow feature may be anything from less than one year (for local features) to hundreds or thousands of years.

The fact that ground waters spend long periods of time moving through very small passages has important implications for those physical, chemical, and biological properties associated with "quality." The mechanical filtering by the porous medium removes suspended solids, and bacterial contamination is eliminated, very effectively, by a process that is not very well understood. The slow rate of movement and the large solid-liquid interface also allow significant amounts of the aquifer minerals to dissolve, often imparting a desirable taste to the water. Thus it comes about that the terms spring- or well-water are generally regarded as synonymous with excellent quality.

Excessive mineralization of ground waters may, of course, degrade quality, producing an objectionable taste or excessive hardness; but it may also impart desirable characteristics such as the purported therapeutic value of mineralized spring water. These considerations apply, to a les-

About 20 per cent of current U.S. water consumption comes from ground-water sources, and this represents slightly less than 10 per cent of the total precipitation which falls on the country; 50 to 100 billion acre-feet of recoverable fresh water lie beneath the earth's surface.

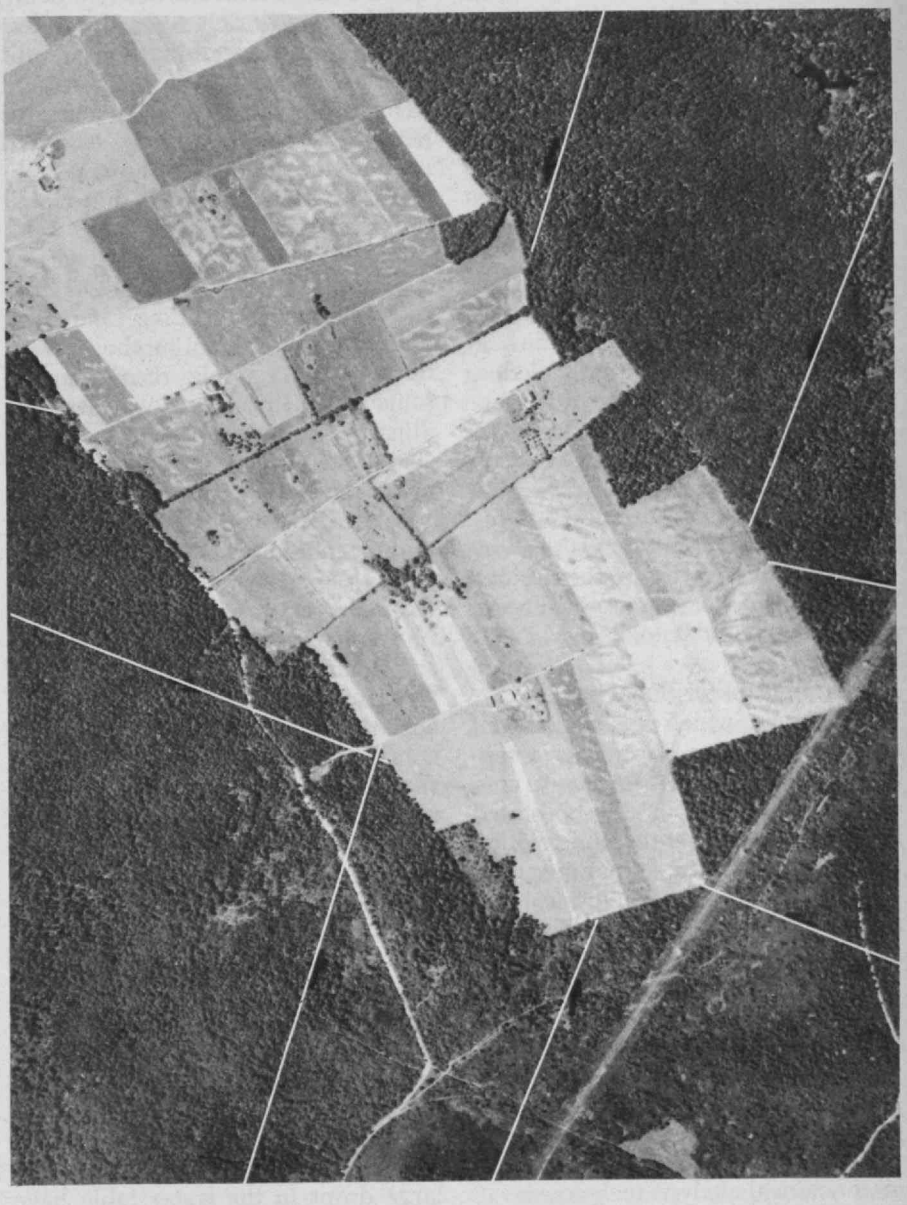
ser extent, to perennial surface streams, whose mineral composition under natural (unpolluted) conditions is strongly influenced by ground-water characteristics, especially during periods when flow is less than average.

So we see that the general behavior of a natural ground-water system can be described in terms of three simplified functional features: it acts as a reservoir, by virtue of the large pore space in earth materials; as a conduit, which can transport water over great distances under the action of gravity; and as a filter, which in a generalized way can improve water quality.

How We Use It

Of the current total water use in the U.S., about 20 per cent is obtained from ground-water sources, and this total use represents slightly less than 10 per cent of the total precipitation that falls on the country. The estimated reservoir of recoverable fresh water below the surface is in the range of 50 to 100 billion acre-feet (in comparison, natural lakes provide a storage of 13 billion acre-feet and man-made reservoirs less than one billion acre-feet).

There are local variations: in many rural and suburban areas, domestic water is obtained primarily from subsurface sources. Although ground water is less important in most urban areas, a number of major cities obtain supplies predominantly or solely from this source. Ground water is used on somewhat over one-third of the irrigated land in the U.S., and that fraction has been increasing—it has roughly doubled since 1940. In industry, ground water represents a relatively small portion of the total water use, which includes such high-volume items as cooling water.



Underground water is very much more abundant than surface water, but finding it still presents problems. One successful method, introduced quite recently by Richard R. Parizek of Pennsylvania State University and Lawrence H. Lattman (now at the University of Cincinnati) is to examine aerial photographs for signs of rock fractures, which tend to act as natural conduits for water. In this Penn State photograph, four straight fracture lines are discernable as they run across the cultivated area. From such photographs the practiced eye can sometimes deduce continuous—probably water-bearing—features approaching a mile in length. Dr. Parizek has a word of caution for developers: once the bulldozers move in, these subtle traces are obliterated; the aerial prospectors should come first.

Ground water has been playing an increasingly important role in the U.S. During the last ten-year period for which data are available, the use of fresh water from the ground increased by over one-quarter, whereas use of surface sources increased by about one-sixth.

Although the growing use of ground water may reflect a new awareness of this subsurface portion of the hydrologic cycle, it is probably due mainly to technological improvements in methods of extracting water from the ground. Ground-water supplies are attractive because the water usually requires less treatment than surface water, because the hazards of contamination from the surface are minimized, and because evaporation losses (which in surface reservoirs may be quite large) are practically eliminated. Ground water is a distributed source which is often compatible with rural or suburban developments, and it can be developed incrementally as needs grow, whereas surface-water systems often require large initial investments in a single facility scaled to some estimated future demand.

On the other hand, surface-water systems—on which more extensive data are available—are more predictable than subsurface systems. This remains true although the fundamental physical basis for predicting the behavior of ground water is thoroughly understood.

Predicting Aquifer Behavior

Using ideas which developed out of experiments by Darcy over a century ago, the general behavior of a ground-water system can be stated in terms of field equations relating pressures, velocities, and appropriate initial and boundary conditions. But actual prediction is in practise usually limited by lack of data on the characteristics of the particular aquifer—permeabilities, general structure, natural recharge and outflow, even simply the extent of the ground-water basin. Prediction capabilities are also constrained to some extent by the limitations of mathematical analysis techniques.

Two different types of analysis are widely used to predict certain features of aquifers. One relates to local conditions around an individual well or group of wells; the other deals with the water budget for an entire subsurface unit or basin—inputs, outputs, and changes in storage—without consideration of the movement of water within it. Both provide important information on their respective scales. More comprehensive methods of analysis, able to account for the movement of water and the distribution of recharge and withdrawal within a complex natural system, have yet to be applied widely, although the past decade has seen significant improvements in this area with the refinement of digital and analog simulation techniques.

With regard to the quality of the water, prediction capabilities are quite limited, current activity being mainly in research towards understanding and describing the relevant phenomena.

The issues involved in ground-water utilization are in any case not confined to these scientific and technical questions. As with the overall subject of water management, a full discussion would include aspects of environmental quality, resource allocation, regional planning, and even political philosophy; in the present treatment, a simple recounting of some typical problems will serve to illustrate some of these aspects. We shall also look at one local ground-water development in terms of some specific problems and the approach to their solution.

Ground Water as a Water Mine

As we have seen, ground water has enormous potential for use and has a significant and growing role in our national water supply. The demand for ground water will almost surely continue to grow, partly because many of the more readily developed surface sources have already been exploited and are continually degrading through sedimentation. There are already several local areas where ground-water basins are being pumped at a rate far in excess of the natural recharge, so that this basically renewable resource is being developed as a fixed resource—i.e., a water mine.

Even in humid parts of the country, particularly in some urban areas, large drops in the water table have occurred as a result of excessive local withdrawals. In most of these cases the natural recharge is in fact still adequate, but the withdrawals are not properly distributed. Many of these problems of excessive "drawdown" are a result of haphazard development and can be alleviated or avoided by good management based on detailed evaluation of aquifer characteristics and the study of models of the entire ground-water basin.

As the demand for ground water grows and the storage potential of aquifers is recognized, the practice of deliberately increasing the natural flow of surface water into aquifers is becoming more attractive. Such "artificial recharge" may be accomplished either by pumping excess surface water into aquifers through wells or by spreading the water in surface basins from which it can infiltrate down to the water table. On a local scale, recharge from streams or lakes can be induced, indirectly, by taking water from wells sunk into nearby alluvial deposits; the surface water is thus drawn through a natural filter and in the process is improved in quality. Land-use practices can also be designed to increase the portion of the rainfall that infiltrates to the ground-water system.

Recharge through the unsaturated zone above the water table is quite unpredictable, for flow properties in this zone are highly variable. Recharge through wells is often limited by the cost of treating surface waters to avoid clogging of the aquifer, which would decrease the capacity of the recharge well. Major technical improvements in methods of artificial recharge will be necessary before this technique becomes broadly applicable. Although artificial recharge has been used successfully in several areas—notably Israel, the Netherlands, and the U.S., especially in California—it is still limited in scale in comparison with the total withdrawal from the ground (in the U.S., it is only a few per cent).

Aquifer Contamination

With the gradual development of water-reclamation schemes based on the recharge of aquifers, the water-quality aspects of artificial recharge are becoming important. Although ground water is generally protected from gross pollution, low-level contamination which may present a hazard in drinking water is now becoming quite common. Typically, the contamination increases gradually, reflecting the slow movement in the aquifer, and is thus less dramatic than surface-water pollution. Thus it is more insidious—and potentially just as serious.

As the demand for ground water continues to increase, this basically renewable resource will more and more frequently be exploited as a fixed resource—a water mine. The quality aspects of artificial recharge then assume major significance.

The discharge of liquid wastes into ground water is a common practice (for example, domestic wastes discharged through septic tanks and cesspools, or industrial wastes which are disposed of through surface infiltration basins or deep-well injection). Ground water may easily be contaminated unintentionally—by, for example, leaching from sanitary land-fills or drainage from agricultural areas where chemical fertilizers and pesticides are used or from highways that have been de-iced with salt. There is also "natural" contamination—salt water intrusion in coastal areas or the upwelling of saline water from deep strata, resulting from excessive local withdrawals which distort flow patterns in aquifers.

A wide variety of contaminants has been observed in ground-water supplies, including bacteria which may be a health hazard, pesticides, petroleum products, oil-field brines, heavy-metal ions, and nitrates and chlorides. It is often not possible to identify the actual source, because the motion of the ground water is seldom well enough documented and there may be several suspects, widely distributed. Because ground water moves so slowly, contamination may require several years, or even decades, to reach points of withdrawal, by which time large quantities of water may already be contaminated. Even if the source is found and stopped immediately upon detection, long periods may elapse before contamination declines. In view of this, the increasing spread of population and the widening use of synthetic chemical compounds offer great potential for unforeseen, widespread ground-water pollution.

Self-Purification Processes

The potential for ground water contamination should be viewed in the context of the natural treatment capabilities of ground-water systems. For example, the aerated zone between the surface and the water table is oxygen-rich, and if properly used it can stabilize dissolved and suspended organic substances of biological origin. This type of process provides additional treatment for sewage-plant effluents that are recharged to the ground water and for the effluents from septic tanks. These natural soil treatment systems are also effective in removing bacterial contamination. However, indications are that some chemical species (e.g., chloride, nitrate, and detergent constituents) are not very effectively removed by the soil and may build up in the ground water.

The most reasonable approach for the future is to evaluate the potential hazards of waste-disposal or land-use activities in relation to the assimilative capacity of the subsurface environment, before the potential contaminants are widely introduced. Where ground waters have already become contaminated, efforts to minimize the damage and eventually eliminate the pollution must be based on knowledge of water movements and of the natural alteration of the contaminants. Subsurface waste-disposal practices should be assessed in terms of long-range overall impact on a ground-water basin.

Long-Range Pollution Control

In the past it has often been implicitly assumed that, if a site accepts wastes without producing immediate and obvious damage at the surface, permanent disposal has been accomplished. This is clearly not the way to protect our ground-water resources. Even so, it might still be argued that, in view of the long time required for an aquifer to become contaminated, pollution should continue relatively unabated on the assumption that technology will provide us with an effective treatment to remove the contaminant, or an inexpensive alternative source of water, before contamination of the supply become serious.

This view ignores the basic role of ground water in the total natural hydrologic cycle. If contaminants permeate throughout the ground water, the chemical characteristics of rivers will be altered. This effect will be most pronounced during the summer months, when river flow is low and consists mainly of ground-water outflows; and this is the most critical time of the year in terms of oxygen supply and algal growth in rivers.

So although water-quality monitoring is an important aspect of pollution control, it is not enough in the case of ground-water systems, where damage could be almost irreversable on the time-scale of human activity. An extensive monitoring program should not be viewed as a substitute for the careful assessment of potential hazards before contaminants are introduced. For this task, our knowledge of the physical and chemical processes governing ground-water quality is in many respects quite adequate; but the techniques for integrating this knowledge into workable basin-wide models is only now developing. Some phenomena will probably require additional research, notably those occurring in the biologically active aerated zone and the degradation of specific synthetic materials in the subsurface environment. In many cases the most severe limitation on our ability to forecast will be lack of information

on the underground movement of water.

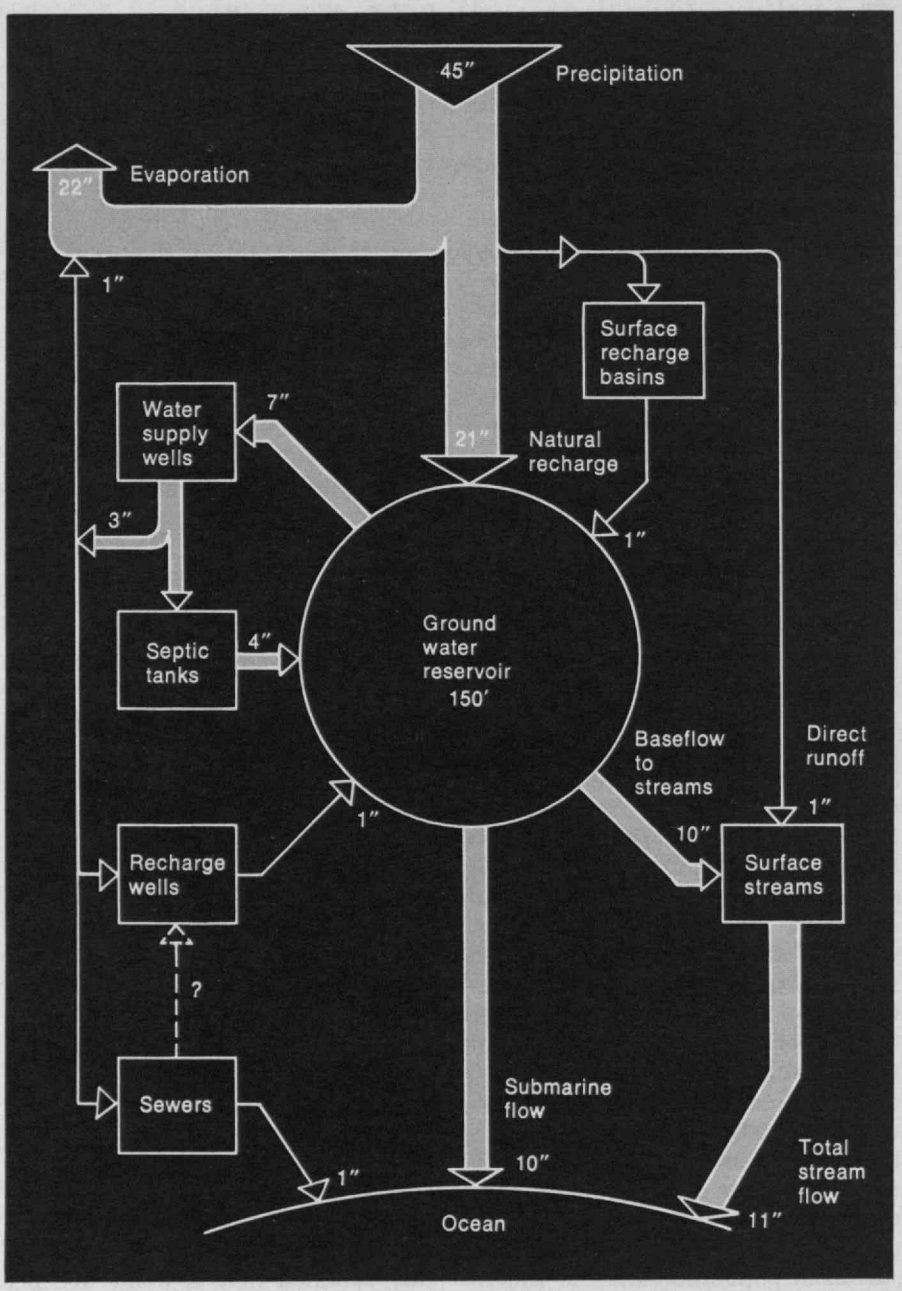
Scientific and technological considerations aside, the management of ground water is also frequently complicated by institutional difficulties. Before we turn to these, it may help to consider an actual case.

Beneath Long Island

The two suburban Long Island counties of Nassau and Suffolk (combined population, 2.5 million) obtain their water almost exclusively from subsurface sources on the island. Water is supplied primarily from high-capacity wells through municipal distribution systems. The island is underlain by excellent aquifers, consisting of unconsolidated glacial and sedimentary deposits of sand and gravel with intervening zones of clay and silt. This wedge-shaped mass of water-bearing materials, which may extend as much as 2,000 feet below sea-level along the south shore, is estimated to contain on the order of 100 million acre-feet of fresh water—equivalent to 150 feet depth of water over the whole area of the island—of which 10 million acre-feet is thought to be usable storage. (In contrast, the entire New York City system of reservoirs, which supply a population of nine million including Kings and Queens counties at the western tip of Long Island, has a storage capacity of somewhat less than 1.5 million acre-feet.)

The general nature of the ground-water resources for the suburban portion of Long Island is shown by the flow chart, representing the average hydrologic cycle (compare with the chart on p. 46) plus some additional elements due to man's intervention.

Long Island receives abundant pre-



This hydrologic cycle of Long Island is expressed in terms of annual flow through each segment and, as regards amounts stored, the equivalent depth averaged over the area of the island. In this case the subsurface portion of the cycle plays a dominant role: most of the fresh water falling on the land goes directly through the ground into the ground-water reservoirs, and stream flow is mainly from ground-water outflows.

cipitation, about half of which returns to the atmosphere by evaporation while a large portion of the rest enters the ground-water system directly. Surface flow is small, and although urbanization has increased surface runoff, a portion of this additional runoff is returned to the aquifer through recharge basins developed to receive storm drainage from paved areas. Of the natural outflow from the ground-water system, half sustains the surface streams and half flows directly to bays and the ocean.

Man's annual withdrawal from the system through wells is equivalent to about seven inches depth of water over the island. This is one-third of the natural input to the ground-water system. This withdrawal is being returned to the ground through septic tanks and (in the case of some industrial uses) recharge wells, since state regulations require that industrial withdrawals—which are mostly for cooling water—be returned to the ground. Over 1,000 recharge wells have been developed for this purpose. A small fraction of the ground-water withdrawal is lost through sewers which discharge treated water to the ocean and through consumptive uses (mainly evaporation from lawn sprinkling). The net withdrawal from the system is therefore quite small compared with the total inflow, and long-term observations of water-table levels confirm that the ground-water system as a whole is very nearly at natural equilibrium.

One essential part of this dynamic equilibrium is the seaward flow of fresh water, which prevents salt water from intruding beneath the island. In some areas of intense development, notably the southwestern portion of Nassau County, where recharge has been reduced with the construction of sanitary sewers, the natural equilibrium has been upset and saline water is slowly intruding. As the demand for water grows—current trends indicate that the population of the area could double in 15 to 20 years—it is likely that the balance between fresh and salt water will be further disturbed.

Ground-Water Pollution

Although septic tanks recycle water by recharging the aquifer, there are indications of rather widespread contamination of the upper portion of the aquifer by effluents. In the glacial aquifer, concentrations of detergents in excess of those recommended for drinking water have been observed, and high levels of nitrate (which may be associated with both sewage and fertilizers) are also encountered. There has been widespread contamination of shallow wells drawing water from the glacial aquifer, and nitrate levels have been increasing also in some deeper wells. In addition, some surface streams in developed areas show quality changes attributable to their ground-water sources.

There have also been a few cases of ground-water pollution from industrial sources. For example, the seepage from waste-disposal basins containing chromium- and cadmium-plating wastes has been observed in the glacial aquifer, forming a cloud of seriously contaminated water extending several thousand feet from the source.

However, it has been possible to continue to draw good quality water from the aquifers by using primarily the deeper wells. During periods of high demand, this deep water is supplemented by adding smaller amounts of water from the contaminated zone, and the resulting quality is still acceptable.

In an effort to eliminate one of the sources of contamination, laundry detergents were recently banned in Suffolk County. A major program of sewer construction is being developed to intercept the waste waters which are now being discharged to the ground through septic tanks. The new sewers and sewage treatment facilities will discharge the treated water to the ocean. This will reduce contamination only at the expense of hydrologic equilibrium, for it will eliminate a major source of aquifer recharge, and since well withdrawals will be increasing at the same time, the net supply of water to the system will be reduced. The predictable reduction in the seaward flow of fresh water brings with it the possibility of significant intrusion of salt water into the fresh water zones.

Thus we have a situation which is not unusual in environmental problems: a solution to one problem—contamination by septic tanks—produces a new threat to the resource we are trying to protect.

Several measures are being considered to minimize this threat; they include recycling some portion of the waste water, after appropriate treatment, via recharge wells or infiltration basins. We can also anticipate that there will be a transition period in which sewers are installed and the contaminants are flushed from the aquifer. If good-quality water supplies are to be maintained during this time, the movement of contaminants through the system must be considered.

Future developments and management of the system will require, as a basis, information on the long-term response of the aquifer system to possible hydrologic changes. As a step in this direction, simulations of the Long Island ground-water system were developed at M.I.T.'s Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics. They use a physical analog: flow through a porous medium can be modelled by viscous flow between parallel plates. A model constructed in the Parsons Laboratory represents geological conditions in a roughly north-south vertical section in the central portion of Long Island, compressing this 30-mile-long section into a 12-foot-long apparatus. The fresh and salt water are simulated by two highly viscous liquid silicones of slightly different density.

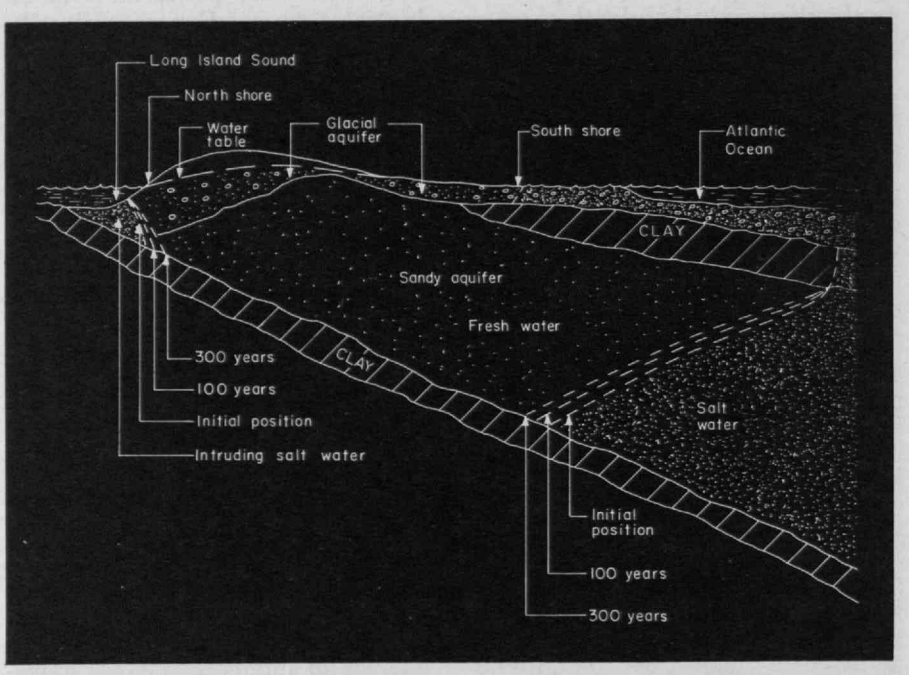
One year of real time takes about one minute in the model. Several important variables can be controlled or observed: the natural recharge rate, withdrawal from wells, well or basin recharge, water table heights, base flow to surface streams, and the progress of the intruding salt water. Several different management alternatives, involving different combinations of withdrawals and recharge, have been modeled.

A typical result shows the movement of the salt-water front from the current equilibrium position in response to rather extreme well withdrawals, equal to the total natural recharge (see cross-section figure on p. 52). The rate of landward advance of the salt water is very slow, and the threat of salt water intrusion is not as serious as may have been originally anticipated. However, other effects associated with such increased withdrawals, notably reduced water-table levels and the subsequent reduction of ground-water outflow to the streams along the south shore of the island, may be important.

The laboratory model is now being used to simulate the motion of con-

taminants which have accumulated during several decades of waste disposal in the aquifer. The findings will be used in developing plans to maintain the quality of water supplies during the transition period when contaminants are being flushed from the system. A typical result (illustrated on the next page) shows the paths and rates of movement of contaminants released in the lower part of the glacial aquifer. Although these initial results do not include the effects of withdrawals from deep wells they indicate that contaminants may persist in the aquifer for several decades or even centuries.

The issues involved in Long Island ground-water problems are complex, and the ultimate solution has yet to be identified. Forecasts of the kind obtained using this model are an essential element of water-supply planning. The generally slow response or large time-scale associated with subsurface water systems becomes very evident.



This vertical section shows the structure of the Long Island aquifer system. The results of a model simulation made at M.I.T. to represent a 300-year period demonstrate the slow landward movement of salt water. This simulation assumed initial well withdrawals equal to the total natural recharge and after 100 years artificial recharge (equal to 25 per cent of the natural recharge) through deep wells near the south shore.

Institutional Complexities

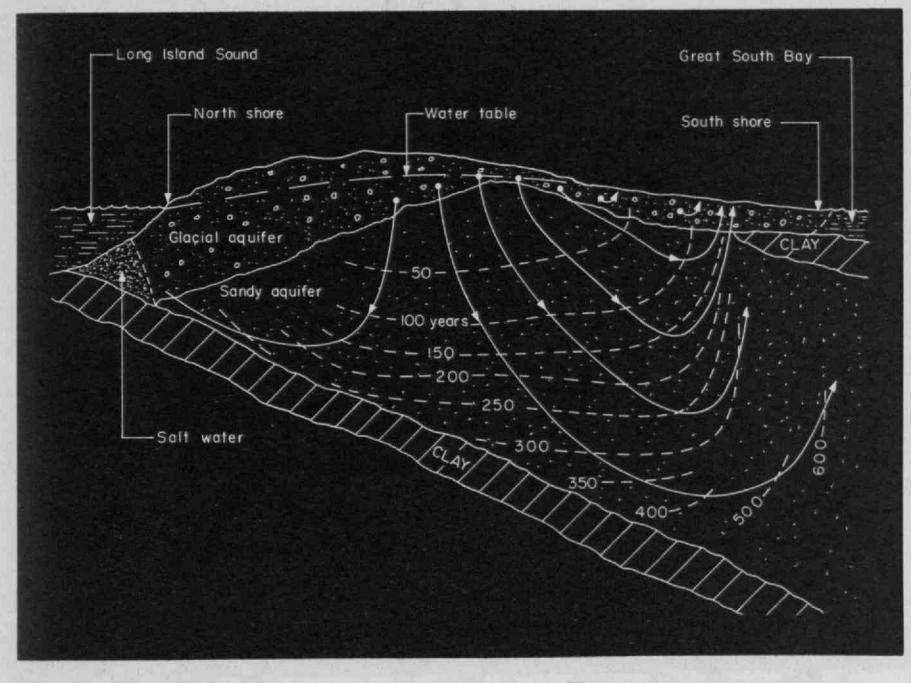
Even when the consequences of some activity can be foreseen, there remain the complications of the institutional setting in which the control of ground-water pollution is attempted.

At the state level, a variety of legal doctrines and regulatory functions have been developed which strongly affect ground-water protection and development in the U.S. Subsurface water is considered to be private property in some states and public in others. Within a given state, surface and ground waters may be treated differently.

Although it is difficult to summarize these legal and regulatory variations, two perverse features are common in some degree to most of them: inconsistency with known physical behavior of ground-water systems, and incompatibility with the current technology available for ground-water development. For example, even when artificial recharge is technically feasible, it will not be used extensively as long as the legal framework remains unfavorable. Thus we should be looking toward a regulatory structure which will encourage the management of ground-water resources in terms of their natural unit—the ground-water basin—and which will recognize the interrelation between subsurface and surface resources.

The federal government has very little direct involvement in the development of ground water (in contrast to the situation with surface water), but it does have an important role in terms of resource evaluation and research. The Geological Survey (Department of the Interior) maintains a nationwide program of ground-water observation and carries out cooperative studies with state and local governments. Several states also have agencies which are involved in the evaluation of ground-water resources. However, it is the local and regional governments which are directly involved in developing ground-water supplies and which at the same time are faced with problems of liquid waste disposal, especially in rapidly expanding suburban areas.

The protection of ground-water resources is obviously important; but political and legal controls cannot succeed unless they are based on a clear understanding of ground-water behavior.



This section of the Long Island aquifer system, based on a model simulation, shows the movement of contaminants through the system. The solid lines represent the paths of simulated contaminants, and the dashed lines indicate the time required for the pollutant to move to the indicated position. The island is 16 miles wide at this section, and the aquifer extends about 1,000 feet below sea level at the south shore.

Quality control of water extracted from the ground is at present primarily the responsibility of the states, although interstate subsurface waters could in principle be subject to federal control. Typically, a state agency will be concerned with the public-health aspects of drinking-water and may therefore require testing of the supply and adopt standards governing the construction of wells and waste-disposal systems.

But regulatory structures which would protect ground-water basins as overall units against gradual chronic contamination, which may not present an immediate health hazard to water supplies, are less clearly developed. Indeed, this area of control is much more difficult because it involves not only intentional waste disposal but also a whole host of potential pollutants associated with different types of land use. For example, chemical fertilizers which dramatically increase agricultural yields and provide the suburban middle American with his version of the Greening of America may also be contaminating ground-water systems.

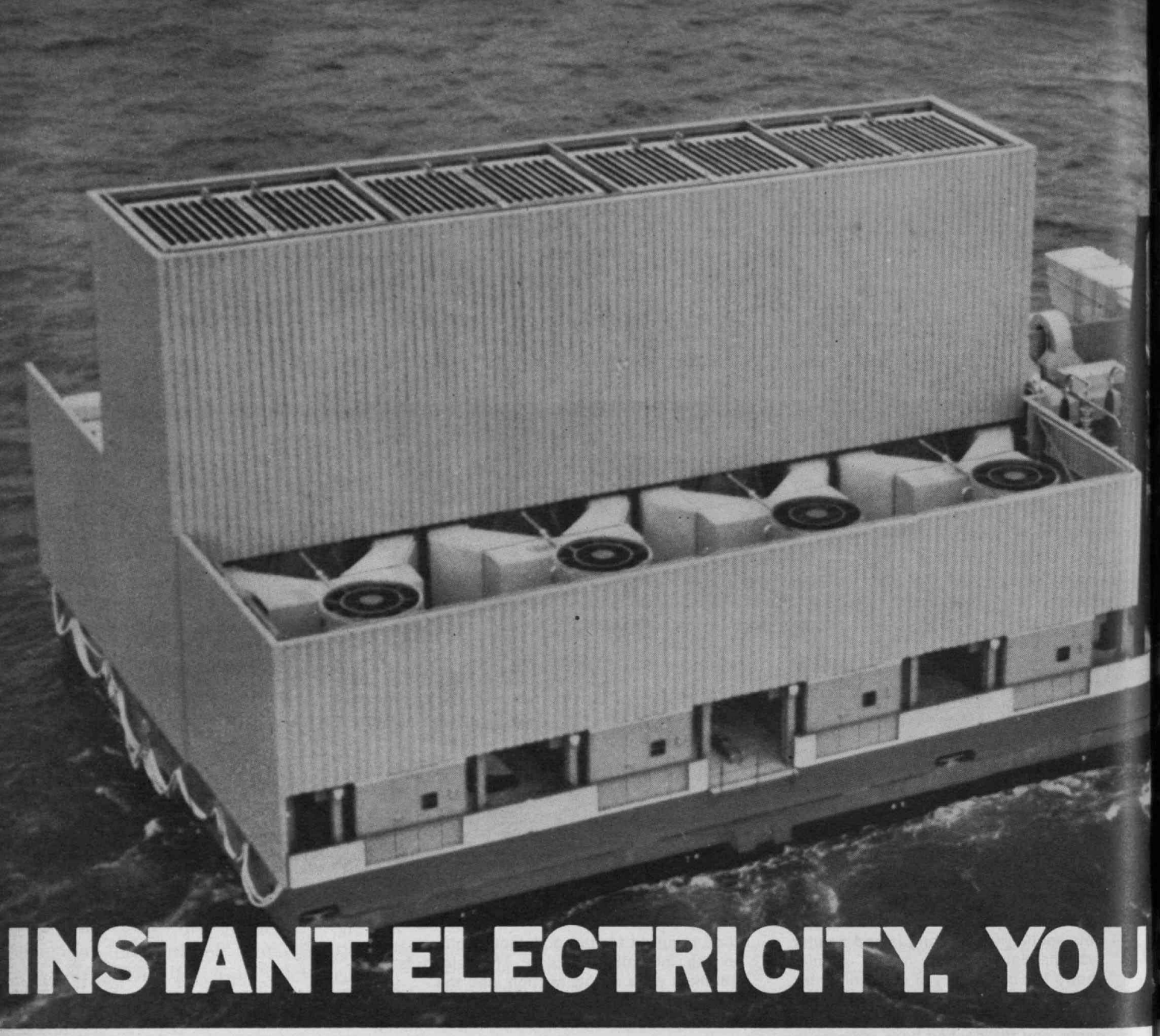
An effective program to control ground-water pollution might comprise measures ranging from public information programs to total bans on certain hazardous materials and might include strict controls on subsurface disposal practices and land use. As Ian McHarg has suggested, the protection of natural recharge areas and aquifers should be an important consideration in regional planning. And whatever the political and legislative answer to potential subsurface pollution may be, it must result from a clear understanding of the actual behavior of ground water, or successful implementation will be impossible.

Suggested Readings

Ian McHarg, *Design with Nature,* Natural History Press, 1969.

R. L. Nace, "World Water Inventory and Control," in *Water, Earth, and Man,* R. S. Chorley, ed., Methuen and Co., Ltd., 1969.

W. C. Walton, *Groundwater Resource Evaluation,* McGraw-Hill Book Co., 1970.



INSTANT ELECTRICITY. YOU

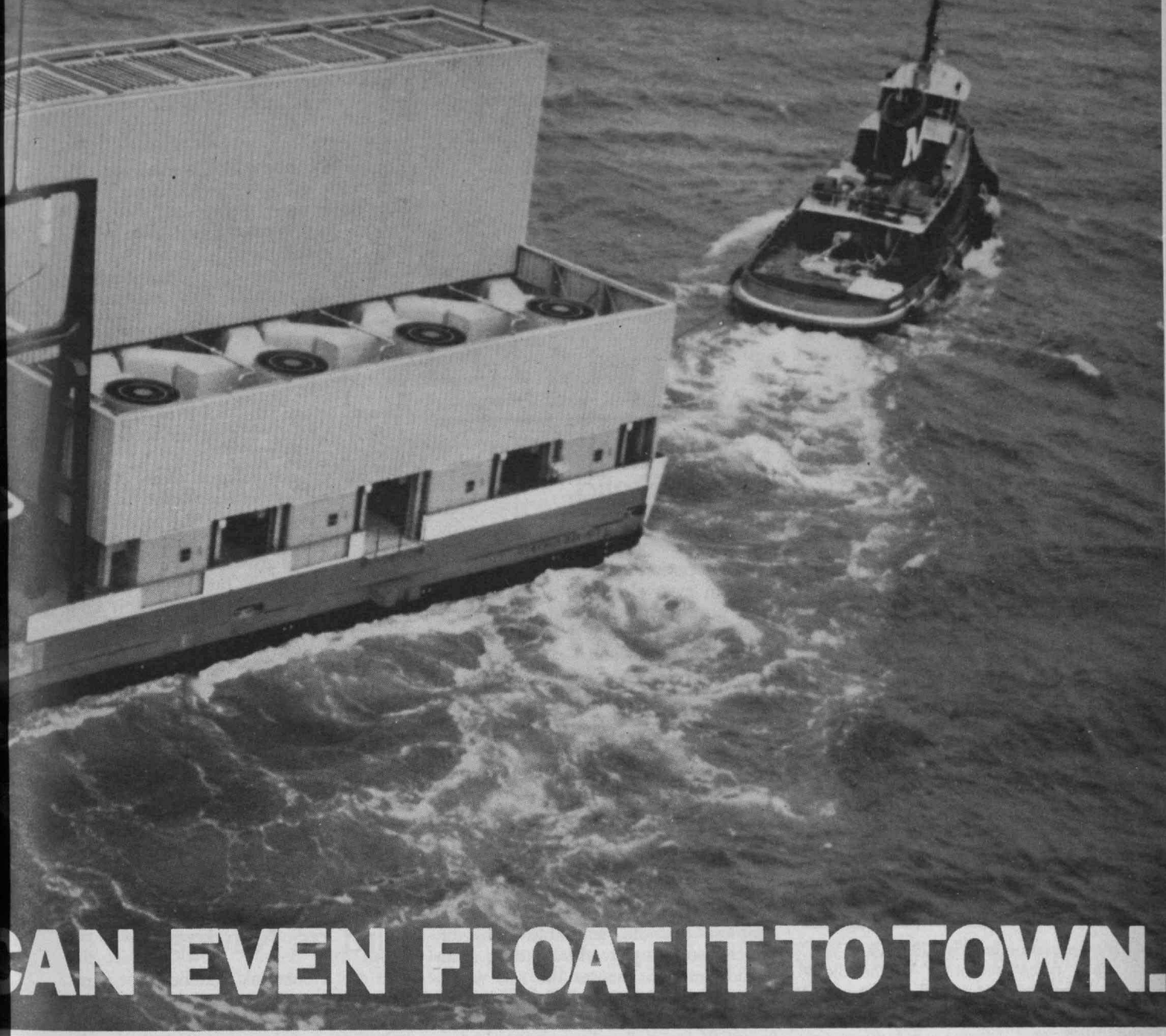
Portable gas turbine generators, mounted on barges and trucks, are being plugged into existing power networks to boost capacity. And nickel's helping make it happen.

One tool that more power companies are using in both their short- and long-range efforts to close the generating gap is a down-to-earth cousin of the jet aircraft engine, the gas turbine.

A typical turbine, hitched to a generator, can produce enough power to light a city of 25,000 people. (Above, *eight* turbines are ganged on one barge. Combined output: 156,000 kilowatts!)

The beauty of the turbine is that it can be bought and set up almost anywhere in a matter of weeks. And it can be turned on and off in mere *seconds*. Which makes it ideal for those muggy summer evenings when everybody gets home and hits the air-conditioner button at once.

Gas turbines have proved such a boon to utilities that sales of them are soaring. Last year, they actually accounted for more than *one fifth* of power companies' total new generating capacity.



CAN EVEN FLOAT IT TO TOWN.

At the volcanic heart of the turbines, where mperatures reach 1,800 degrees, only specially signed superalloys can be used. Almost all of ese alloys contain a high proportion of *nickel*— to 78 percent. Nickel is vital for the properties quired for dependable turbine service. It helps provide alloy stability and corrosion resistance.

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Trend of Affairs

Trends This Month

LIFE SCIENCES

A behavioral study of a rat's blinking eyelid . . . The mystery of bird navigation revisited . . . Was Sir Isaac Newton a victim of mercury? . . . Forest fires as a natural ecological tool.

EARTH SCIENCES

Lightning-modification . . . Weather in the ocean . . . Undersea riches—but can we profitably mine them? . . . and whence, in fact, do they come?

INNOVATION

The changing pattern of federal commitments to academic research . . . The growing responsibilities of engineering . . . Technology for the steady state . . . Academic creativity on the market.

BUSINESS

Cable television seeking its place . . . A new price-predicting methodology . . . The computer industry turning around . . . The future for industrial dynamics

ASTRONOMY

Watching Mars by radar and satellite . . . A telescope for the orbiting astronomical observatory . . . The lunar laser reflector at work.

SOCIETY

Human isolation is sometimes more lengendary than real.

LIFE SCIENCES

Learning and the Rat's Eyelid

Behavioral psychologists have discovered a great deal about the behavior-learning performances of animals (one of them even claims to possess a general purpose "behavioral technology" applicable to humans), but what goes on in the nerves and brain during the process of learning remains a puzzle. Such a behaviorally simple learning operation as, for instance, a rat learning to push a lever is really quite complex, even in terms only of sensory inputs and muscular outputs—making the task of studying the learning process at the neural level a daunting one indeed.

Dr. Robert D. Hall of M.I.T.'s Department of Electrical Engineering is trying to reduce the complexity to a manageable level by working with the simplest possible learnable behavior. He chooses the proverbial batting of an eyelid; and he chooses the rat, whose eyelid is chiefly controlled by just two muscles and is involved in relatively few of the animal's other activities.

Dr. Hall observes eyelid motions in two ways: by an optical system fixed to the rat's skull (to observe the eyelid itself) and by electrodes implanted in the eyelid to register its muscle activity. The optical system also carries a tube through which a puff of air can be blown at the rat's eye, stimulating a natural reflex which provides both a means of causing the rat to blink when required, and a starting-point for conditioning (in this context, "learning"). Even the relation between optically-observed blinking and electrical muscle activity is far from simple.

Without apparent external stimuli, a rat blinks, on average, 40 times an hour—but it tends to blink in bursts with intervals of 10 to 20 minutes between, the bursts seemingly occurring at times of high overall activity. The animal also blinks in response to sudden noise (including, in this experimental set-up, the noise of the food-supply system) and as an accompaniment to eating.

Work so far includes some preliminary successes with conditioning. "It must be clear," Dr. Hall comments, "that the notion of a simple effector system is a relative one, for these few little muscles of the rat's eyelid produce an assortment of behaviors with considerable variety and more than adequate complexity."

The ultimate task is to separate out, from all the influences on a nerve governing a particular muscular activity, those influences involved in a particular learned change in behavior, and thus to trace the process of learning back through the nervous system. "The task is certainly formidable," admits Dr. Hall, "but if it is viewed a step or two at a time, those who pursue it need not seem quixotic."—*F.W.*

Bird as Navigator

You are a bobolink, hatched last summer in a marshy meadow along the Assiniboine River near Lavenham, Manitoba. You are now—in February—more than 4,000 miles away, in southern Brazil. In two months you will have found your way back—not only to Manitoba but to the very field in which you hatched.

How?

You know how to orient yourself with the sun, and you have an internal clock by which to compute the sun's bearing. But mostly you migrate at night.

You know in daylight how to find places by local landmarks—rivers and trees and perhaps others that we cannot imagine. But even in the full moon you migrate in flight lines, without reference to the land.

You know how to orient yourself with the stars, but you can find your way under an overcast—or even *in* one—as well as under a clear sky.

You cannot predict the weather (or can you?), but you make most of your migration when you have a tail wind.

You can even make allowance for how far off-course you are being carried by an angling wind.

You are temporarily—but only temporarily—disoriented by a disturbance of the natural magnetic field.

How can all this be?

No one knows. Even with a new tool —tracking radar, with which they can observe night migrations and count the number and species of individuals involved—bird migration remains for ornithologists a near-complete mystery of evolution, said Stephen T. Emlen, Associate Professor of Zoology at Cornell University, in a progress report to the American Association for the Advancement of Science's Section on Engineering this winter.

Present research makes it clear that birds use some combination of systems and data—not a single, superhuman navigation plan. But the systems are redundant, and this makes them especially hard to sort out. When he succeeds in doing so, said Dr. Emlan, man may have new insight which will help him, too, find his way through his ever-more-complicated world.—*J.M.*

The Mercurial Sir Isaac

Was Sir Isaac Newton as mad as a hatter? J. R. M. Seitz of Harvard believes that he was, at least by around age 50. He thinks Sir Isaac's was the proverbial occupational hazard of old-time hatters—a nervous and psychological disturbance whose symptoms included palsy and paranoia—and that it was due to mercury poisoning.

Sir Isaac Newton worked with mercury in very large quantities. For example, one of the experiments he describes in his *Optics* involved repeatedly distilling kilograms of it, and he did this in a closed room.

At the age of 45, Newton's productivity began abruptly to decline. Six years later his condition was a matter of serious concern to his friends, and they persuaded him to leave his place of work and to rest for six months. He appears to have recovered, for three years later he became an unusually effective Master of the Mint.

Mr. Seitz presented the mercury-poisoning view of Sir Isaac's breakdown, in a paper written jointly with M.I.T.'s Professor Jerome Y. Lettvin, at the winter meeting of the American Physical Society at M.I.T. in December. Our records of Newton's work with mercury raise the question, he said, not of whether he might have poisoned himself, but of how he managed to survive at all—and we have his letters, with their palsied handwriting and their accusations of persecution, and outbursts of rage, against his closest friends.

The next step might be to subject some of Sir Isaac's hair to electron-microprobe analysis. This non-destructive technique has already been used to establish that an attempt was made to poison Napoleon with arsenic. The growing hair retains for posterity a record of the body's changing metal content, which can now be read off along the hair's length. Some of Newton's hair is in the possession of the Royal Society. Mr. Seitz hopes that the American Physical Society and the Royal Society, in a joint project, might analyze a single Newtonian hair, to discover whether indeed its owner had a dangerous dose. If so, then it becomes of more than academic interest that he regained his health.—*F.W.*

Let Fire Burn?

The assumption that forest fires are wastefully destructive deserves skepticism.

Indeed, convinced that nature is better served if left alone, the National Park Service now lets lightning-bred forest fires burn themselves out (so long as human life or property are not endangered) in certain sections of the sequoia-conifer forest of Kings Canyon and Sequoia National Parks.

Why?

Bruce J. Kilgore, Research Biologist with the National Park Service, listed eight reasons for the American Association for the Advancement of Science this winter:

☐ Fire helps make a soft, friable soil, and it consumes much of the accumulated litter which otherwise hinders seeds from reaching that soil.

☐ Partially burned litter—which is the usual result of fire—holds more water on the forest floor than unburned litter.

☐ Fire helps return minerals to the soil which are otherwise tied up in slowly decaying vegetation.

☐ Fire kills many fungus populations.

☐ Many shrubs are fire-dependent (in one case, seeds with hard coatings will not germinate unless cracked by the heat of a fire), and wildlife in turn depends on these shrubs.

☐ Periodic fires suppress the understory growth of trees which otherwise challenges the sequoia seedlings.

☐ By burning in chance patterns, fires maintain a mosaic of forest ages and types, assuring variety and seed-stock.

☐ Fire is selective: it consumes drier—old or diseased—trees and leaves healthy trees.

The fact that we so fear forest fires may make the fires themselves more fearsome, said Dr. Kilgore. If periodic small fires fail to keep ground fuels and understory trees under control, future fires are likely to be more destructive than nature intended.—*J.M.*

Forest fires are neither unnatural nor catastrophic. Indeed, the health and variety of some forests—as well as of many animals in them—may depend on periodic burning. Naturally-evolved forest ecosystems have adapted to lightning, but not to human fire-fighters.

EARTH SCIENCES

Or Modify Lightning?

While the National Park Service contemplates the beneficial effects of lightning-originated forest fires in the Sierra Nevada (*see above*), the U.S. Forest Service is busy with storm modification research to try to reduce the amount and effects of lightning in the northern Rockies.

Two approaches are possible, Donald M. Fuquay of the Northern Forest Fire Laboratory (Missoula, Mont.) told the American Association for the Advancement of Science this winter:

☐ Cloud-seeding can increase the rain associated with lightning-carrying storms; if rainfall is increased, the forest-fire potential is obviously lowered. The heat of fusion released by cloud-seeding also has the effect of disrupting the organization of a storm and so limiting its development.

☐ Storms which contain ice crystals, supercooled droplets, *and* frosted aggregates on which condensation can take place produce more lightning than storms in which any one of these three

is absent. Thus direct lightning modification may occur when cloud-seeding reduces the ice crystal density in a storm.

Seeding experiments in the 1960s confirmed that the amount and duration of lightning can indeed be reduced—and particularly that the nature of lightning, when it occurs, can be altered, Mr. Fuquay told the A.A.A.S. He promised continuing studies of lightning modification and of its environmental and ecological impacts.—*J.M.*

Undersea Weather

Oceanic circulations probably bring to fish in the seas the same kinds of changes in "weather"—from cool, clear days to hot, "muggy" ones—that atmospheric circulations bring to terrestrial residents. And if we fail to understand how atmospheric weather works, we are very much farther from understanding the same thing in the seas.

Oceanographers know well enough that ocean waters arrange themselves in layers—cold, dense fluid at the bottom, warmer, less dense water near the surface. And it is clear that there is a constant, if pedestrian, circulation between these two—upwellings of water from the deeps and complementary downflows from the surface. But the movements are small when compared with the areas over which they occur, and observation is almost impossible.

Now Henry M. Stommel, Arthur Voorkis, and Douglas Webb of the Woods Hole Oceanographic Institution (Dr. Stommel also teaches at M.I.T.) have reported (*American Scientist*, November/December, 1971) the exchange of surface and deep water in the Mediterranean. They regard this sea as a small ocean system whose vertical circulation may be extrapolated to—and be easier to measure than—the world's great seas.

Early in 1969 a research team including these scientists and representing as well the British National Institute of Oceanography, the Museum National d'Histoire Naturelle (Paris), and the Consiglio Nationale de Richerche (Rome), using six oceanographic research vessels, found an area of the Mediterranean south of France and Spain where the density of surface water was markedly greater than elsewhere—almost matching that of water near the bottom. They set out some uniquely sensitive vertical current meters and waited patiently for the onset of the mistral, the French Riviera's cold north wind.

When the wind finally came their postulations proved correct: their meters detected "a really remarkable process of vertical convection." The surface-to-bottom stratifications of sea water were quickly wiped out in an area 20 miles wide and more than 100 miles long.

Salinity and temperature became uniform, almost from top to bottom of the ocean, and in this area the group obtained what it believes are "the first direct measurements of really large vertical velocities and displacements in the open ocean;" they were so large that the scientists—taking their cue from Jules Verne—dubbed the effect "the maelstrom in the Mediterranean."

A series of complex eddies and vortices—the instruments were grossly inadequate for measuring them—were obviously present both during the mistral and after the winds died while the sea regained its more steady state. The scientists assure us that "some day oceanographers are going to have to develop means of measuring detail of the three-dimensional velocity structure of the ocean on various scales." In the meantime, it is already clear that there are in the oceans patterns of fluid flow which must look to fishes much as turbulence in the air is revealed to us as weather.—*J.M.*

Metals from the Sea

Minerals from the sea are not exactly "an untapped treasure ready to fall into our hands," says Marne A. Dubbs, Director of Ocean Resources Research for Kennecott Copper Corp.

No one doubts that sea-floor nodules contain an immense resource of copper, nickel, cobalt, and manganese, among others. Yet to imagine economic exploitation, Mr. Dubbs told the American Association for the Advancement of Science this winter, you have to imagine a technology capable of handling up to 10,000 tons of nodules a day, yielding perhaps 100 million lbs. a year of nickel and copper. Only when continental resources are far more expensive than today can one imagine such a technology being economic, and recycling may still further delay the dawn of ocean mining for these two metals.

The same is true for most of the minerals that are present in seawater, including gold, uranium, and heavy-hydrogen. Though tremendous quantities of these materials are in the world's oceans, the costs of recovery—the capital costs of the structures, and, especially, the energy for moving water past them and processing it on the way—appear simply prohibitive.

Exceptions: among the dissolved minerals, magnesium and bromine are already obtained by electrolysis; and among the solid minerals, Mr. Dubbs forecast commercial refining of manganese from marine ores by 1980.—*J.M.*

Ocean Minerals and Undersea Volcanoes

Large tracts of the ocean floor are densely covered with minerals rich in iron, manganese, cobalt, and a number of other interesting metals. One question is how to mine them (*see left*). Another is where they came from. John B. Corliss of Yale's Department of Geology and Geophysics proposed an answer to the second question during a recent visit to M.I.T.

It has been suggested that the iron-manganese deposits are in some way related to submarine volcanic activity. But what exactly is the mechanism that so efficiently separates some elements, and not others, out of a stream of molten rock erupting into the ocean from below?

Dr. Corliss brings together evidence from sources as diverse as a rock-dredging expedition near the mid-Atlantic ridge, a joint Russian-Indonesian study of a recent volcano in shallow Indonesian waters, and the drilling of a partially-cooled pool of lava from an eruption on one of the Hawaiian Islands.

The rocks from the Atlantic floor—formed by the cooling of volcanic material—are of interest because they fall into two distinct types, he says: "pillow" rocks, which solidified quickly, and "holocrystalline" rocks, which cooled more slowly. They differ in composition; the holocrystalline rocks are relatively depleted in iron, manganese, cobalt, and the rare-earth metals.

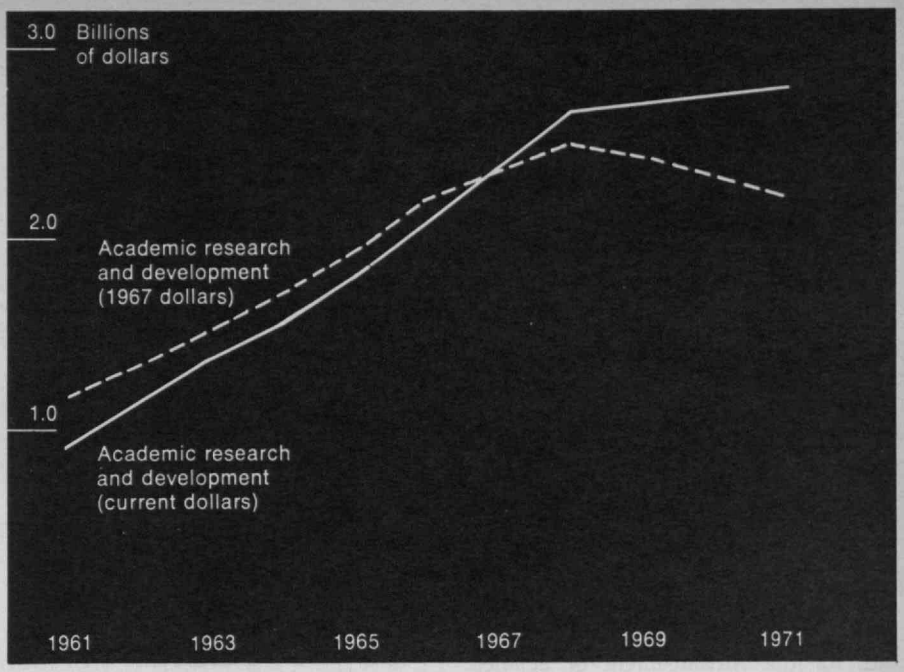
Dr. Corliss suggests that "pillow" rocks represent the original composition of the molten volcanic magma. When the magma emerged through the sea-floor and encountered the water, it formed a crust beneath which cooling and solidification were retarded. In these conditions, some minerals crystallized preferentially before others, and as the freezing zone advanced through the material these elements became concentrated in the solid while others were progressively rejected into the liquid.

The team that drilled a pool of lava which had collected in a crater following an eruption in Hawaii encountered just this situation, and was able to sample not only the new rock but also the still-uncooled liquid. These samples proved to be relatively rich in silica, iron, manganese and copper. They also yielded a separate sulfur-rich liquid with a strong affinity for iron, copper, and nickel. After solidification, and during cooling, certain elements initially stable in the solid were released. According to Dr. Corliss these natural fractionation processes "may lead to the mobilization of several elements initially present in the lava."

In the case of an undersea volcanic eruption, the next stage is the cracking-

open of the crust, allowing the seawater to reach the buried hot rocks. Chemically, seawater is a mixture of salts well chosen for the job of leaching out the iron, manganese, and certain other metals. The Russian-Indonesian expedition found, near the submarine volcano, jets of hot seawater containing iron and manganese hydroxides. On the seafloor around the vent were brown deposits of iron and manganese, apparently precipitated as this hot water cooled.

And this, says Dr. Corliss, is where the ocean's ubiquitous iron/manganese layers come from. If the "pillow"-type basalt is taken to be the starting material, the holocrystalline rock is missing a great deal of these two elements—far more than is present in normal seawater, but about the right amount to account for the mineral layer which lies (overlaid in most places by later, slower sedimentation) on the ocean floors.—*F.W.*



Though college and university research and development expenses rose at an annual rate of 10.9 per cent (current dollars) in the decade from 1961 to 1971, the effects of inflation reduce this (expressed in constant dollars) to a gain of only 6.6 per cent overall and—during the last three years—to a decrease of 3.4 per cent. An academic research and development budget of $1 million in 1961 would, in constant dollars, have been worth only $673,000 in 1971, says the National Science Foundation.

INNOVATION

A New Ball Game

Richard M. Nixon, calling for increased American productivity with which the nation can compete on world markets, proposes more—and more effective—research and development. But the new day dawning—if it comes—may be quite different from the past.

Despite the reshuffling of priorities and responsibilities, there simply won't be enough money, in 1972 dollars, to restore the spirit of unfettered innovation in basic research which—from today's perspective—seems to have existed a decade ago with 1962 dollars. So it will be pull-and-tug—between scientists, and between fields as well, says Frank Press, Head of M.I.T.'s Department of Earth and Planetary Sciences, who is a former member of the President's Science Advisory Committee and now a member of the National Science Board.

☐ Between fields? "Nobody is smart enough, or has yet had courage enough, to assign priorities between fields," said Professor Press at an M.I.T. seminar this winter. The field which seems to be "hurting the most" will simply get the money when the time comes. In the 1973 budget it's radio astronomy. Perhaps in 1974 it will be the oceanography fleet—or something else.

☐ Between scientists? "Because there's not going to be enough money to go around," said Professor Press, "the high-quality, first-class proposals will be supported first." That, he agreed, is a drastic change from the philosophy of the 1960s, when geography as well as quality was important in the distribution of funds.

In this new situation, he said, it's unlikely that new centers of excellence can be encouraged. Even some existing laboratories may have to be closed down to keep the best people and the newest machines busy.

And sometimes being first-quality won't be enough. If you want to get a piece of the action on a large project, said Professor Press, you'll have to find some partners and work together. The result will be more and more cooperative programs—such as M.I.T. has with the Woods Hole Oceanographic Institution, and the Northeast Radio Observatory Corp. which operates the Haystack Observatory.—*J.M.*

The Three Stages of Engineering

Engineering is maturing into a third stage of accountability, with a totally new responsibility for "identifying meaningful technological solutions and participating in making them socially and politically feasible," says Alfred H. Keil, Dean of the M.I.T. School of Engineering.

In remarks prepared for members of the M.I.T. Corporation early this winter, Dean Keil outlined his three stages of engineering responsibility this way:

☐ In the beginning, engineering was concerned simply with "the creation, and in some cases the operation, of man-made physical facilities to meet the needs of society." Most of these activities used machines and structures, and later on combinations of those, to meet expressed needs at lowest cost. At this stage, said Dean Keil, "the value structure for the engineer consisted of engineering feasibility and product cost."

☐ As technology became more complex and rendered more complex the society which it served, the engineer added a new dimension to his thinking: he had "to see the individual products of engineering in the context of the operational systems of which they were integral parts." The aeronautical engineer, for example, has to see his aircraft as an intricate flying machine and also as a part of an air transportation system. The value structure was suddenly broader: "it was the performance of the overall system which counted, not the optimum performance of each component."

☐ Now the engineer's responsibility is expanding again. In addition to technical feasibility and system efficiency, "we now must include in our considerations the social cost and social feasibility," said Dean Keil—"social cost" meaning the "impact on both the natural environment and the society." On the traditional engineering decision-making processes there must now be superimposed a new set of issues: "The development of concepts to decide what to design is becoming of ever greater importance," Dean Keil said.

Technology for the Steady State

Can a "steady-state" economy be a prosperous one?

That depends on what you mean by "steady-state," says Athelstan F. Spilhaus, Fellow of the Smithsonian Institution's Woodrow Wilson International Center for Scholars.

"Steady-state" does not mean conservation of nature as it was 1,000—or even 100—years ago. It does not mean unchanging goods and a static technology. It need not mean a reduced number of choices for people ("To increase choice is to increase freedom," Dr. Spilhaus says). It does not mean a prohibition on experiment.

"There can be exciting change, continual improvement without escalation of the amount of things," Dr. Spilhaus told members of the American Association for the Advancement of Science this winter in his address as retiring President. A steady-state world, he said, "should open up a great new field of scientific and technological experimentation and discovery to develop the 'saving' industries to produce things to satisfy new wants with less materials, using energy more efficiently.

"When the public is told that their choice is between having 'dead babies or dead lakes,'" Dr. Spilhaus said, this overstatement "is a disservice to the legitimate cause of economy. Choices like these are no choice at all."

The truth, he said, is that with continuing innovation, suitably guided by long-range planning, there can be increased choices and "variety to the texture of life" without having growth a central economic objective.—*J.M.*

Inventions for Sale

☐ To separate iron filings from a slurry, pass the slurry through a column filled with a stainless steel wool-like matrix in a d-c magnetic field; the iron filings will cling to the matrix. Clean the matrix occasionally by flushing the column in an a-c field.

☐ To study the engineering properties of a compressible soil, use a consolidometer. It varies the effective stress on a soil sample and measures one-dimensional stress-strain and consolidation properties.

☐ To give an aircraft pilot instantaneous information which is better than his instincts of "feel" about the take-off performance of his plane, give him a computerized system whose active element is an arrangement of two strain-gage accelerometers.

More than 200 such concepts and devices, in 15 categories, are in the portfolio of inventions covered by M.I.T.-owned patents or applications, and over 150 of them are described in a new handbook of "Licensing Opportunities" compiled by M.I.T.'s office of Patent Administration. The point, says Lawrence Gilbert, O.P.A. Director, is to help bring potential users of patents the kind of information they need to make a first judgment of whether or not an idea is likely to have interest.

M.I.T. annual reports suggest that the Institute—which itself manages patents deriving from work in M.I.T. laboratories—usually receives some $2 million annually in royalties. In addition, inventors receive a share of patent royalties, and the interests of sponsors of research leading to patents —including the federal government— are protected.—*J.M.*

BUSINESS

The TV Cable: What Will It Bring Whom?

Television programs now come into some six million U.S. homes—mostly in rural areas—by cable instead of through the air, and the number of cable TV subscribers in the U.S. has been growing fairly steadily at 22 per cent a year for the past decade. After some 20 years of free growth and increasing regulatory chaos, the industry has now been given a set of rules which resolve the competitive issues between cable and conventional broadcasters along the lines of a compromise set forth in the fall by the White House Office of Telecommunications Policy.

The subject has been invested with a certain amount of drama by various notions of public boons and complex technological benefits to be expected from cable TV, most of them based on the idea that the cable which brings TV programs into a home might be used also for some other purposes. These might include carrying messages back from home to transmitting station (for example, purchasing decisions or political "citizen feedback"—see *Technology Review* for January, 1971), medical consultation, tutoring or other educational services, and—ultimately—universal person-to-person videophone.

It is also suggested—and this has been put into practice in at least one city—that some cable TV programs should be originated by individuals and small groups of ordinary citizens, to stimulate neighborhood life. (The Federal Communications Commission (F.C.C.), as of March 31, requires all new cable-TV systems to make one "public access" channel available.)

John E. Ward of M.I.T.'s Electronics Systems Laboratory, who provided the technical appendix to the recent Sloan Commission report *On the Cable,* believes that all of these uses will soon be technologically feasible—at a price. The simplest of them, provision for sending signals back along the cable from the home, would roughly double the cable TV cost to each subscriber; nobody has yet demonstrated that it could be made to pay. (The F.C.C. now requires new cable systems to have some two-way capacity.)

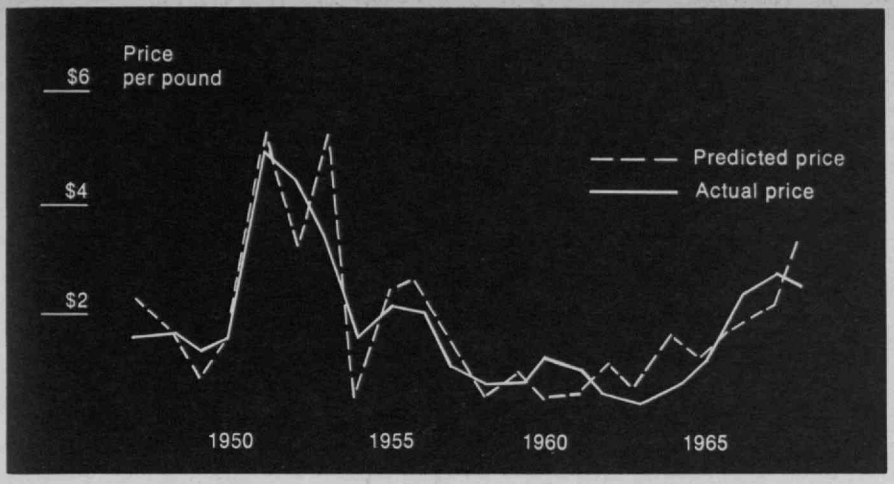
In its present, commercial form, cable TV is simply a means of bringing existing broadcast programs to places where over-the-air reception is poor or non-existent. But the present tumult and shouting arise because another, larger-scale benefit is possible: frequency-spectrum limitations are removed (giving the Sloan report its subtitle, *The Television of Abundance*). This means that cable TV can bring a new set of programs into an area where all broadcast TV channels are already occupied. This is a capability which the competing broadcasters deplore, and which the new F.C.C. regulations permit, with restrictions. On the other hand, the added bandwidth may also be used for non-commercial ventures, if anyone can be induced to pay for them.

Since cables for TV cannot be laid without the cooperation of local authorities, city and state governments have hitherto been able to enforce conditions of their own. These have ranged from old-fashioned bribe-taking to New York City's insistence that each of its cable-TV operators provide one channel on which members of the general public can show their own work. One municipality has even attempted to ensure public ownership. The F.C.C. will now have a degree of control over local strictures, through its ability to withhold certification.

How far this initially rural medium will penetrate into the cities depends on how the operators judge the economics of the game, now it has to be played according to the F.C.C. rules. Conversely, some commentators—including Mr. Ward—think the extent of penetration will have a strong bearing on which of the technically possible extra services prove economically feasible.—*F.W.*

Microeconomics: Predicting Prices

When the price of mercury rises, the mining companies naturally find it worthwhile to mine lower-grade ore. To the miners working along a vein of ore, this means that, instead of just taking the metal-rich center of the vein, they cut a thicker slice, including the lower-value ore further from the middle. In this way (it would seem to follow) the supply of mercury will be



The price of tungsten, 1947-1968, is shown as it actually was and as a computer model by Charles River Associates "predicted" it. For each year, the model works from the conditions governing the market at that time. Mere economics is not enough: the successful modeller must also understand the technology and institutional arrangements of the particular industry.

increased.

Not so. The input capacity of the smelters that extract the metal from the ore remains the same. When they receive lower-grade ore, they produce less mercury. It takes at least a year for a price increase to make any impression on smelting capacity, and in the interim the relation of price to supply is the opposite of what would be expected from general principles.

This piece of practical knowledge is enshrined in one of a large assembly of equations which Charles River Associates uses to simulate the economics of the mercury industry. The mercury model is one of about 20, each for a different metal, which this Cambridge, Mass., company has developed over the last five years. Each model computes supply, demand, and hence price, given the conditions governing the industry during the year of interest—for example, in the case of lead, the number of automobiles in use and manufactured.

"It is absolutely vital," says James E. Burrows of C.R.A., "to have a complete and thorough understanding of the institutions and technology of the industry being studied." He admits that, in the abstract, few would deny the importance of this type of knowledge, "but much of the economic research I have seen in industry founders on this reef," says Mr. Burrows. It is necessary to know "the behavior patterns of the firms, the government policies affecting the industry, the technology of production and consumption, and the behavior of inventories over time.

"In general, the cookbook approach to industry modelling is doomed to failure," Mr. Burrows insists.

Speaking at an M.I.T. symposium on econometric modelling early in the winter, he justified this last statement by outlining C.R.A.'s models of the tungsten, cobalt, and aluminum markets. The first is a classic competitive market, although complicated by very large U.S. government purchases (some at a guaranteed price far above the world market price) and by large and erratic sales by China. The cobalt industry, in contrast, is on the supply side virtually a monopoly, dominated by Union Miniere. The C.R.A. model of the aluminum industry is different again—"much more behaviorally oriented." Supply is mostly in the hands of six companies; "no one firm can assume that the price of aluminum is not affected by its own market decisions."

An example of the success of one of these models (that is, the success it would have had if used in the past) is shown. The work so far has all been for the U.S. government, and the forecasts are not at present publicly available. However, C.R.A. is open for business which would not infringe the confidentiality of the results that the government has paid for. The tin market, for instance, has not yet been modelled.

Of course, each commodity market exists in the environment of the others. The demand for copper depends upon the price of aluminum, and vice versa. "We are currently embarked," said Mr. Burrows, "on a program of performing routine updating and forecasting with models of 15 natural resource commodities, and we are building towards the day when all of these models can be simulated simultaneously."—*F.W.*

Upward, Computers

After two years of below-average results, the U.S. computer industry will now resume its 18-to-19-per cent annual growth rate, says Patrick J. McGovern, President of International Data Corp. The average growth rate in 1971 was only 8 per cent.

The industry's reduced growth in 1969, 1970, and 1971, says Mr. McGovern, came when "the end of a computer generation cycle" coincided with a period of recession for U.S. high-technology industry. The result was that computer users found ways to become more sophisticated in using existing computers, discovering that they had in effect built up an "overcapacity" during the late 1960's.

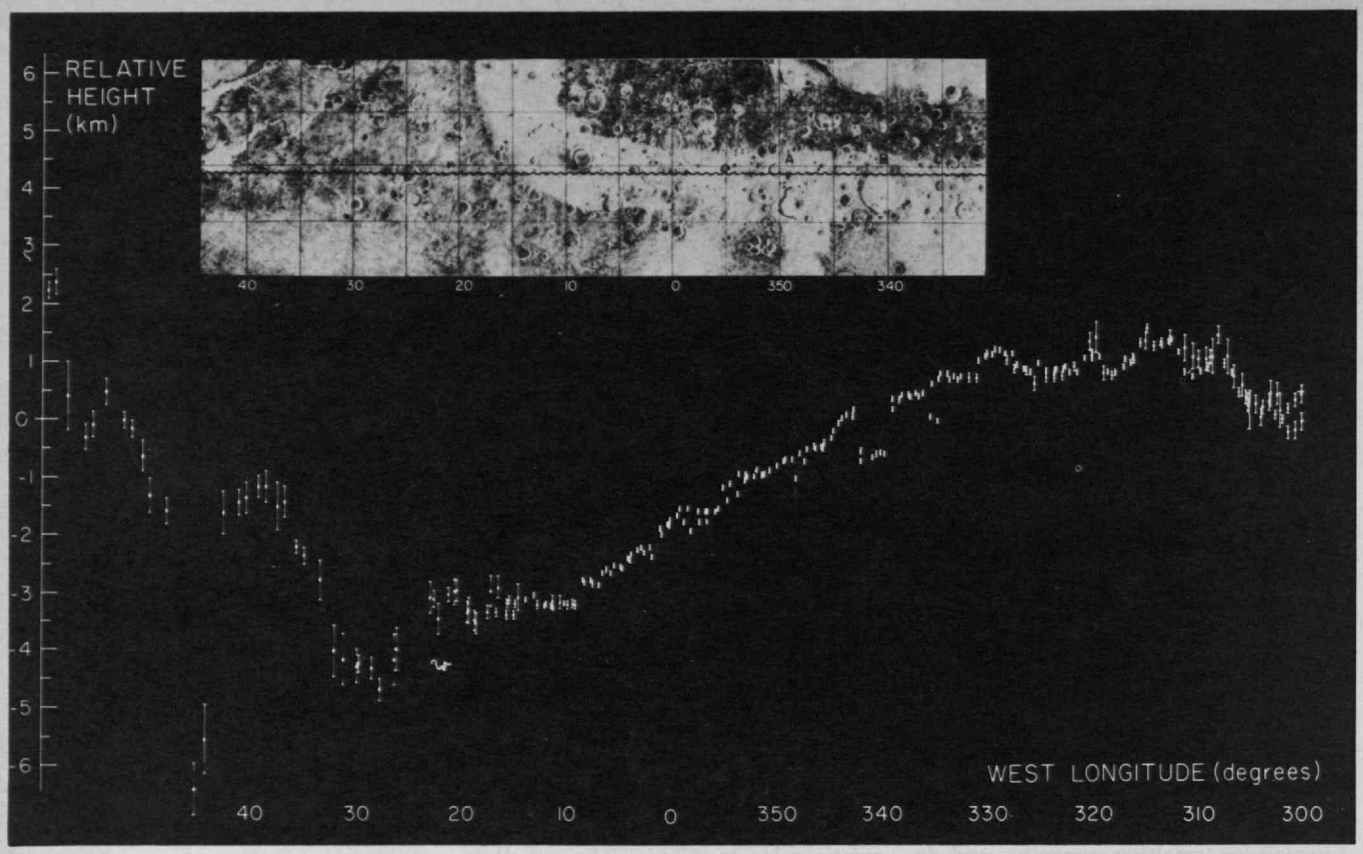
Now, says Mr. McGovern, the rate at which machines are retired has stabilized. In 1971 U.S. users retired or returned to their manufacturers over $1.4 billion worth of computers while buying $4.3 billion of new American-made equipment. Meanwhile, U.S. computer makers also sold $3.2 billion of computers overseas in 1971, 15 per cent more than in 1970.—*J.M.*

What Became of Industrial Dynamics?

The school of computer modelling associated with the name of M.I.T.'s Professor Jay Forrester, and currently best known for simulations of cities and of the entire globe, started out as a management-consultancy technique. This original application is still thriving, somewhat out of the public eye, and is accumulating a useful stock of experience. At an M.I.T. Industrial Liaison Program symposium on "system dynamics" early this winter, David W. Peterson outlined progress made in 15 years.

A computer model of a company's operations, he said, can be used in three ways: to clarify the details of policies which, while they remain in the minds of management, are inevitably less than perfectly defined; to evaluate proposed actions by observing their effects in the model; and actively to design new policies. One general observation: What ails a company is very often something that, to the management, has been a source of pride. The traditional wisdom, in other words, is not so wise—which may be why many really successful ventures have the reputation of being "exceptions to all the rules of management."

A model does not necessarily have to be highly accurate to give useful new insight. Mr. Peterson cited the case of a long-established shoe manufacturer in the Boston area whose sales had been constant for many years. Apparently the company never suspected what the computer simulation quickly revealed: if it made more shoes, it would have no difficulty in selling them. This seems to be a more common mistake than might be expected.



This combination of photograph and diagram correlates a Mariner photograph of the surface of Mars with a radar altitude profile made along a track (wavy line) 16.5° south of the Martian equator by M.I.T. astronomers using the Haystack Observatory radar in the summer of 1971. The white patch at the extreme left is shown to be a gorge 2.5 miles deep, the lowest point observed on Mars to date. A sharp discontinuity in the radio scattering properties of the Martian surface—an area of extremely high surface resolution between 10° W. and 315° E. longitude—is shown to correspond to a light-colored region of the Martian surface. There are abrupt breaks in the radar record corresponding to craters between 350° and 330° W. longitude, the radar record revealing their depths ranging up to one-half mile.

A similar case at the other end of the spectrum was the Route-128 company with "the perfect product", a $2,000 off-the-shelf measuring instrument of unique accuracy and performance. The salesmen never lost a sale. Earnings climbed steadily. The founders called in the consultants because they feared that one day competitors might appear, and because they did not understand how they had succeeded and thus could not be sure that they would continue to do so.

It turned out, in the model, that never losing a sale was not a good symptom, but a bad one: the company was approaching only the most obvious customers, and ignoring a much larger market where there would be some difficulties but great rewards. The company doubled its sales force (i.e., hired two more men) and as a result is surviving the present recession, which would probably otherwise have wiped it out.

Good industrial models, said Mr. Peterson, are usually based on hypotheses as to what is going on. So they tend to be specific for particular kinds of situation, rather than for particular companies. Industrial dynamics experts are thus accumulating a range of "ready-made" models, which can be applied instantly, rather like the diagnostic experience of a doctor. System dynamics is becoming less of a research technique and more of a handy tool.

Even when this is true, however, the patient may still delay his cure by the time it takes him to believe the prescription.—*F.W.*

ASTRONOMY

Measure of Mars

Even while Mariner 9 was sailing toward its orbit around Mars last summer, M.I.T. scientists were using the Haystack Observatory radar to map terrain features on that planet with unprecedented accuracy. By fall they announced completion of a survey revealing the vertical dimensions of mountains, valleys, craters, and other topographic features in a belt roughly 100 miles wide around the entire planet just south of the Martian equator.

Among the features of the topography, totally unknown previously, are a gorge some 2½ miles deep and over 250 miles long with an average slope of 6°, and a crater some 1,200 miles across and more than a mile deep.

The data from the radar observations indicate an overall Martian altitude variation in the belt studied of slightly less than 10 miles from the highest peak to the lowest valley. This variation is similar to, and supports with greater precision, the topographic variation found by the same astronomers for the northern Martian altitudes. It represents a "top-to-bottom" span roughly the same as that of Earth with its oceans drained. The Martian atmosphere is very thin, so that topographic features of this scale rise through the whole thin atmosphere and extend into space.

This implies intense changes in atmospheric conditions over very short surface distances, of which high winds are inevitably a consequence; Mariner 9 observing teams can easily conceive Martian winds averaging as high as 250 miles an hour, Carl Sagan, Professor of Astronomy at Cornell University, told the American Association for the Advancement of Science this winter.

Assume that Mars is composed in general of the same stuff as Earth and moon. Small particles of this stuff—dust less than 100 microns—would reflect sunlight and have about the color of the migrating light areas we see on Mars. Larger particles—200 microns

more or less—would look dark. And in the thin Martian atmosphere 250-m.p.h. winds would be adequate to keep everything moving and drifting.

This model of a planet dominated by dust storms which shift in response to seasonal variations seems to take care of several mysteries. The "canals"—the early observers never meant to call them that, and only confusion in translation from the Italian led to that name—are wind-blown dust entrained in Martian valleys. The changing albedo of Mars—seasonally blooming life?—is seasonal deposition and denudation of dust.

The continuing radar studies of Mars were reported by Professors Gordon H. Pettengill and Irwin I. Shapiro of the Department of Earth and Planetary Sciences, in association with A.E.E. Rogers of the Haystack Observatory staff; the Observatory is operated under agreement with M.I.T. by the Northeast Radio Observatory Corp.

As the intensity of the Martian dust storm declines and Mariner 9 photographs become clearer, the radar data—which already correlate with photographs returned from Mars by earlier Mariner flights—are becoming important in scaling and interpreting Mariner 9 photographs.

Radar must be managed with great precision to measure topographic features at such accuracy; the procedure is to analyze the different lengths of time required for a radar pulse to travel to and from Mars when the beam bounces off topographic features of different elevations. New equipment completed for the Haystack Observatory last summer permits recording the Martian altitude with a precision of better than 100 yards. With Mars only 33 million miles away during the favorable opposition of 1971, this represented distinguishing the height of a marble from a distance of 10,000 miles.—*J.M.*

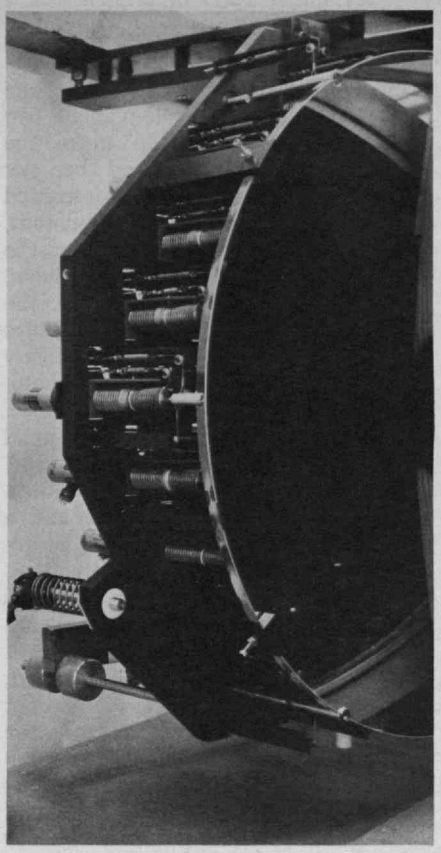
A Telescope Mirror That Bends

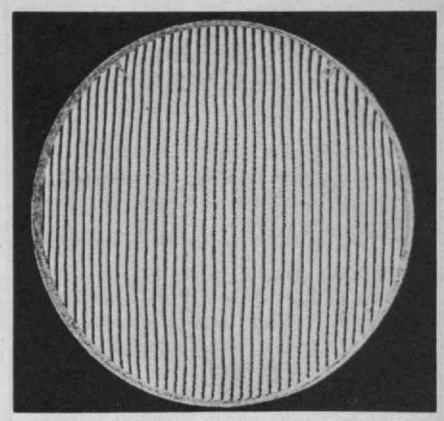
Although there are no firm plans as yet, it has been suggested that a future orbiting astronomical observatory might be equipped with an optical reflecting telescope as large as the biggest ones in use on earth, or even larger. But a giant mirror, designed to hold its shape rigidly with the needed accuracy, weighs many tons. The Perkin-Elmer Corp. has therefore been working on lightweight, flexible mirrors whose shape can be corrected while in use.

The first photograph shows one 30-in. "deformable mirror" used in a small-scale trial. It began as a conventional rigid fused-silica mirror, four inches thick, with a surface accuracy of 1/50 of a light wavelength. Then the back three-and-a-half inches were removed. The result was a surface with errors of up to two-and-a-half wavelengths (in spite of the annealing of the original quartz block to render it "strain-free"). An interferogram of this surface is shown (essentially a contour map of the surface errors in half-wavelengths).

The second interferogram shows the result of allowing the active control system to come into action. Perkin-Elmer's Director of Optical Systems, Herbert F. Wischnia, reports that the original accuracy was restored.

The control system employs, in this case, 58 active supports, each driven by a small electric motor, plus three passive reaction points. Using helium-neon laser light, an interferogram which reveals the uncorrected form of the mirror is automatically generated and examined. A logic system computes the necessary corrections and activates the servo-motors accordingly. The whole system constitutes a closed feedback loop which continues to function until it can detect no errors.—*F.W.*





This 30-in.-diam. deformable mirror constructed by the Optical Group of the Perkin-Elmer Corp., half an inch thick, is insufficiently rigid to hold its shape to astronomical standards. But behind it are 58 motor-driven supports, by which the form of the mirror can be restored to the necessary accuracy. Lightweight deformable mirrors might be of use in future orbiting observatories. For example, a deformable 360-in. mirror would weigh only about eight tons, as compared with the 75 tons of a conventional mirror of the same size. The two interferograms show the surface errors, before and after automatic correction, of the 30-in. mirror. They were made with light having a wavelength of 6328 Å; the dark fringes can be regarded as contour lines measuring the error heights in half-wavelengths.

Shine On, LRRR . . .

Though millions watched as astronaut Neil Armstrong placed the first "lunar ranging retro-reflector" on the moon's surface two and a half years ago, the ranging experiments have now drifted into the semi-obscurity in which science is usually conducted. But the blackout is confined to publicity: the original reflector—actually an array of "corner" reflectors—is still working as designed, with no significant degradation in performance since the first returned signals were picked up August 1, 1969.

Dr. Carroll O. Alley, Jr., Professor of Physics at the University of Maryland, reports that with the original reflector and the three others that were placed subsequently, observers "are regularly measuring the distance from a laser light source on Earth to the reflector on the moon with an accuracy of 30 cm." Improved equipment on Earth, furthermore, should soon improve the accuracy to three centimeters.

Three 45-minute periods are set aside each day for measurements using the

107-inch telescope at the University of Texas' McDonald Observatory, yielding about 20 measurements per month. Why so few measurements? For one thing, light takes a while (about two and one-half seconds) to make the round trip to the moon. And then not every shot works: Each transmitted laser pulse contains about 10^{20} photons, of which only about ten re-enter the telescope on returning from the moon. Since most of those are lost in the filtering and measurement system, says Professor Alley, "it's only once in every few shots that you get a photoelectron in the photomultiplier tube," even when all the equipment is lined up and working.

Even though his experiment has been going well for more than two and a half years, Professor Alley has no results to report; the main objective is to look for very small disturbances and oscillations which might have time-constants on the order of years.

These small variations, it is hoped, will give us more information about gravitation (Was Einstein right? Is the gravitational constant decreasing as the universe expands?), geophysics (What are the relative velocities of the several large plates of the planet's surface? What is the exact motion of Earth's wobble about its axis, and with what does it correlate?) and selenophysics (How does the moon wobble? How is its mass distributed?).

Of the four widely separated reflectors on the moon, the fourth was not placed until last September 15. Unlike the other three, which were placed by NASA astronauts, the final one was built by the French and carried to the moon aboard Luna 17 on the back of the Soviet remote-controlled moon rover Lunokhod 1. The experiment is still not under way on the scale that Professor Alley would like; he is now working to establish a world-wide network of observatories to engage in measurements from widely separated points on Earth. Only then, he explains, will it be possible to fully exploit the system's potential for geophysical research.—*R.A.*

SOCIETY

Speedy "Primitives"

When medical researchers from the National Institutes of Health arrived in one New Guinea village which had had no previous contact with our civilization, they found a major building program going on. The villagers were copying, as best they could from a distance of a few miles, what they had seen happening in a neighboring village which some Westerners had visited a short time before. If the strange visitors wanted new buildings of a particular shape, for whatever unknown reason, then that is what they would get—preferably before they even arrived.

The National Institutes of Health is concerned with isolated human communities because these offer the possibility of studying disease-immunity patterns of a very much simpler kind than are found in the U.S. For example, there is a society which retains the pure antibody to the strain of influenza which broke out in a massive epidemic around 1919; nobody has had 'flu there in the last 50 years.

The N.I.H. immunological expeditions to isolated groups around the world provide, extramurally, the chance for a great deal of informal anthropology, and this opportunity has not been lost on Dr. Carleton Gajdusek of N.I.H., who spoke at M.I.T. this winter under the auspices of the Institute's Education Research Center. Among his observations of "primitive" societies (meaning, roughly, societies based on hunting and foraging):

☐ It is a mistake to assume that a "Stone Age" culture is a relic of an earlier period in the history of mankind. "Primitive" life styles have in many cases been adopted within recent centuries by people from complex civilizations, including "the descendants of Cervantes and Roger Bacon."

☐ Cultures can not only change very quickly; they can in fact rewrite their own histories in a matter of a decade. Dr. Gajdusek described one New Guinea group which was hardly beyond the "Stone Age" 14 years ago when he first visited them. Now there are among them independent businessmen and Toyota mechanics. When he showed these people a film made of them made on his first visit 14 years before, they were vastly amused at what they took to be a backward tribe in another part of the country. They flatly refused to believe that they were looking at the same individuals who sat in the audience.

☐ Some groups are culturally very much richer than others, producing a steady output of complex music and art while their neighbors make almost nothing that a casual visitor cannot quickly learn. Genetically, they are the same people (for there is constant intermingling between neighboring groups). What makes the difference is the size of the communication network in which a group lives. The culturally unproductive groups are the rugged individualists who decide to "go it alone."

☐ In relation to this last point: it is the uncultivated individualists who most readily take to Western ways, and they therefore tend to become the new leaders as a country is "developed."
—*F.W.*

Earthquake Problem

Puzzle Corner
Allan J. Gottlieb

The great event to which I referred in my last column is now accomplished, and I want to express publicly my thanks (and Alice's) to my thesis adviser and his wife for their help with the small reception on January 7; when he took me on as thesis student, I doubt that Michael Shub realized how many fringe benefits he would have to provide.

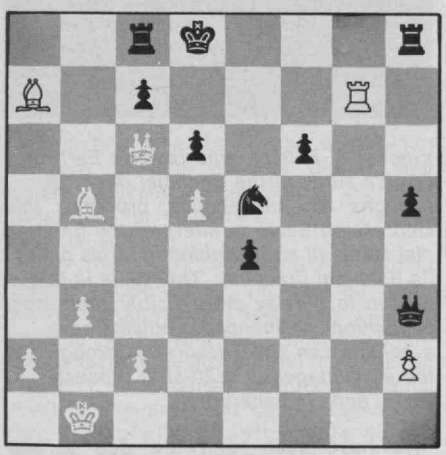
Another note of fairly local interest: John ("Boog") Rudy, a regular player in Puzzle Corner, is anxious that I call our classmates to the Class of 1967 reunion in Cambridge the first weekend in June. He used to complain that my throws from deep short would sting when he caught them; for that much of an ego boost, he deserves this plug.

Send problems and solutions to me at the Department of Mathematics, University of California, Santa Cruz, Calif., 95060.

Problems

We will start this installment with a chess problem so easy I was able to solve it. This one is from Peter J. Meschter:

66 Given the following, White to move and checkmate.



Here's a West Coast problem from R. Robinson Rowe:

67 The earthquake of February, 1971, near Los Angeles caught one Pacoima (near the epicenter) family at breakfast. Father had imbibed his orange juice, Mother had had a few swallows, and Junior had just reached for his. Then the quake quaked, and all three dashed for safety in the open patio. At the first lull, Father peeked in the window at the shambles inside, noticing one apparent inconsistency. On the breakfast table two juice tumblers had tumbled over but the third stood erect. Guess which. This suggests a problem: suppose each tumbler was cylindrical, 2" dia. by 6" high, of uniform thickness, weighing 130 g. empty and 430 g. full. What depth of juice would give it maximum stability in an earthquake and what seismic acceleration would have left it erect while tumbling two others?

Now a Phase II problem from Harry Zaremba:

68 A customer in a supermarket, observing a clerk finish stacking oranges into a pyramid with an equilateral triangular base, asked the clerk if he knew how many oranges were in the stack. Admitting he didn't, the clerk remarked that an eccentric old lady once told him if the number of oranges along an edge of the pyramid is known, any clerk worth his ability to stack oranges could find the sum. Could this be possible? thought the customer.

The following, from Ermanno Signorelli, is a sequel to the first Speed Problem this month, which should be read first:

69 There exist(s) other ratio(s) of sequential whole numbers ($n, n + 1, n + 2, n + 3, n + 4; n > 0$) which satisfy the geometry of SD1. Find the ratios and show that no other satisfying ratio(s) exist(s).

This power problem is from Harry A. Smith:

70 On TV I watched a ship skim across the water borne up by what the commentator said were jets of water and that 25,000 h.p. was being exerted. I am not a scientist, but I know that water is incompressible and therefore jets of water can be projected on the ocean surface and thus propel the ship. Now, why is it not possible to propel jets of water against fins on the outside of a turbine, and so propel the turbine to power electric dynamos and create electricity? The jets, I think, can be synchronized so that each fin is hit in turn by a high-powered jet. To begin the power process of operating the pumps to create the high-powered jets a diesel engine could be used. (I note that a garden hose projects a stream of water under only 10 to 15 lbs. pressure, and that a new fire engine purchased by the city in which I live can project water with great force using a small diesel engine.) Once the system was operating, could the jets be powered by electricity from the generator? This is a kind of perpetual motion idea. The application is to set up many small power plants for individual cities and towns. The question is, Would there be any electric power left over from the generator and turbine to transport?

Speed Department

This is the one referred to in problem 69 above, from Ermanno Signorelli:

SD1 Consider a rectangle with sides a and b, each of arbitrary length and with $a \neq b$. Inscribe five and only five triangles in the rectangle. Each triangle must have two and only two sides wholly in common with two other triangles. Identify the position of the five triangles if the ratio of their areas is 4:5:6:7:8.

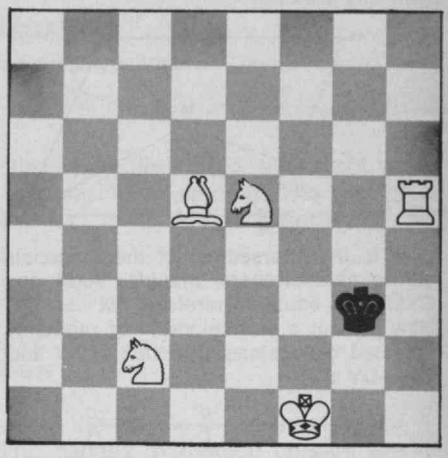
Greg Gagarin submits the following:

SD2 A man in an outboard motorboat is travelling upstream on a river crossed by two bridges exactly one mile apart. As the boat passes the upstream bridge, the man's hat falls overboard. This is unnoticed for 10 minutes—at which time the man, feeling the hot sun upon his head, turns the boat around (assume no time lost). Without changing the power setting, he catches up to his floating hat under the downstream bridge. What is the speed of the current in the river?

Solutions

Here are solutions to the problems published in *Technology Review* for December:

51 Given the following, show how white can mate in three moves.



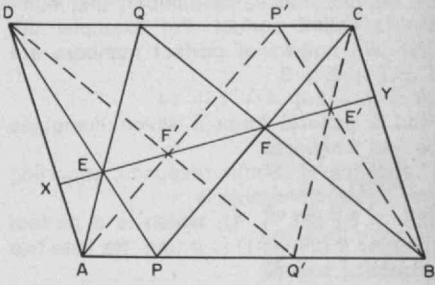
The solution comes from Richard Bennett:

1. B to R1; K to B5
2. K to N2; K to K5
3. K to N3

52 A railway car is travelling in a straight line at a constant velocity. A helium-filled balloon is tied to the floor of the car with a piece of string. The car is then decelerated at a constant rate. Relative to the car, what is the initial direction of movement of the balloon? What is the steady-state direction during deceleration (i.e., at what angle is the string to the floor during deceleration)?

Everyone says the balloon moves forward, but I disagree. I feel that the air in the car will go forward creating a high-pressure area forcing the balloon backwards. Opposing views have been expressed by Alan LaVergne, Jeffrey Miller, R. Robinson Rowe, Robert Shooshan, and Harry Zaremba.

53 Given the parallelogram ABCD with points P and Q located anywhere on AB and CD. Segments BQ, AQ, DP, and CP are drawn; the intersection of AQ and DP is designated E, the intersection of BQ and CP is F. Line EF is drawn intersecting AD at X and intersecting DB at Y. Prove $AX = CY$.

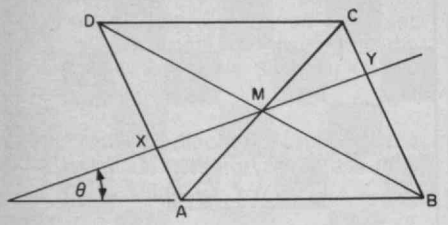


George Clahane submitted both geometric and analytic solutions. For his geometric solution, he adds the dashed lines in the drawing above:

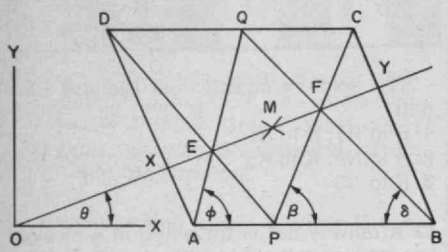
BP' parallel to DP
AP' parallel to PC

DQ′ parallel to BQ
CQ′ parallel to AQ.
Triangle CBP′ = triangle ADP;
therefore CP′ = AP.
Triangle CP′E′ = triangle APE;
therefore CE′ = PE.
Triangle CYE′ = triangle AXE;
therefore AX = CY. Q.E.D.

Mr. Clahane's analytical solution begins with this drawing.



If M is the intersection of the diagonals of the parallelogram, triangles AXM and CYM are equal. Therefore AX = CY. Now lay out a parallelogram of randomly selected dimensions, direction of XY and OX—OY axes.



Drawn to scale, it can be shown that:
For line OXY, tan $\theta = 3.5/9$
For line AQ, tan $\phi = 7/2$
Line OXY: $y = 3.5/9 \cdot x$ (1)
Line AQ: $y = (x - 6) \cdot 7/2$ (2)
Equate (1) and (2) and find
$x_E = 6.75$,
$y_E = 2.625$
$x_P = 6.75 + 2.625/4.375 \cdot 3.75 = 9.00$
For line QB, tan $\delta = 7/7 = 1$,
$y = (15 - x)$ (3)
For line PC, tan $\beta = 7/3$,
$y = (x - 9) \cdot 7/3$ (4)
Equate (1) and (3) and find $x_F = 10.8$, as determined by the intersection of QB and OXY.
Equate (1) and (4) and find $x_F = 10.8$ as determined by the intersection of PC and OXT.
This seems to prove that points E and F lie on a line through the intersection of the diagonals of the parallelogram. Therefore AX = CY.

54 If the sum of all the factors of a number equals that same number, that number is called perfect. For example, the first two non-trivial perfect numbers are
$6 = 1 + 2 + 3$
$28 = 1 + 2 + 4 + 7 + 14$
Find a general formula which computes perfect numbers.

Lawrence H. Smith responds, reporting that one such formula is
$(2^N - 1)(2^N - 1)$, which is a perfect number if $(2^N - 1)$ is prime. He lists two groups of factors:

$$\left.\begin{array}{l} 1 \\ 2 \\ 2^2 \\ \cdot \\ \cdot \\ \cdot \\ 2^{N-1} \end{array}\right\} \text{Group A}$$

$$\left.\begin{array}{l} (2^N - 1)\ 1 \\ (2^N - 1)\ 2 \\ \cdot \\ \cdot \\ \cdot \\ (2^N - 1)(2^{N-2}) \end{array}\right\} \text{Group B}$$

Group A sums to $(2^N - 1)$;
Group B sums to $(2^N - 1)(2^{N-1} - 1)$;
and the total is
$2^N - 1 + (2^N - 1)(2^{N-1}) - (2^N - 1)$
$= (2^N - 1)(2^{N-1})$.
Q.E.D.

The next two smallest perfect numbers are $496 = (16)(31)$ and $8128 = (64)(127)$, according to Mr. Smith. "I do not know," he writes, "if my formula generates every perfect number, but there are no others less than 8192. By the way, I believe that $(2N - 1)$ is prime if N is prime, but this has never been proved nor disproved."

Also solved by Roger Milkman.

55 The author and the Editors have conspired to confuse themselves—and in the process readers' responses to problem 55 in the December issue of the *Review* have been destroyed. The Editors have apologized to me, and I in turn do so to the readers.

Hope and Despair

Book Review:
Vincent A. Fulmer
Vice President and Secretary, M.I.T.

The New Depression in Higher Education
by Earl F. Cheit
McGraw Hill Book Co.,
New York, 1971, 170 & xxii pp.

On the theory that our society is conditioned to act most easily on the quantities we can measure, there is a clear need for a simple yardstick to prompt greater national as well as institutional concern for the cultural tragedy of our time—the financial dismantling of American higher education.

Earl F. Cheit's book, *The New Depression in Higher Education*, reports to the Carnegie Commission of Higher Education and the Ford Foundation on financial conditions at 41 public and private colleges and universities in the United States. We are all indebted to him for the suggestion that it is possible to characterize the financial dilemmas of the colleges and universities more systematically than we have in the past. Mr. Cheit skillfully cuts through the complexities of educational finance to tell us whether alma mater is on the verge of heading for financial difficulty, in financial difficulty and headed for trouble, or really in the depths of trouble itself.

He found a shocking 71 per cent "headed for trouble" financially—or already there—by the spring of 1970. Since then college finances have even worsened.

The College Depression Scale

1—Reducing further additions to reserves
2—Cancelling further additions to reserves
3—Borrowing from reserves
4—Spending reserves with no intention of replacing them
5—Borrowing from unrestricted gift income for budget balancing instead of capital additions
6—Spending unrestricted gift income for budget balancing with no intention of replacing it to capital
7—Borrowing from income accumulations in designated endowments for use in general purposes
8—Spending income accumulations in designated endowments for general purposes
9—Borrowing from the realized gains of the portfolio
10—Spending the realized gains of the portfolio with no intention of replacing them
11—Borrowing from *un*realized gains of the portfolio
12—Spending *un*realized gains
13—Borrowing internally from the general endowment of the college
14—Spending the general endowment with no intention of replacing it
15—Borrowing from designated endowment, with legal sanction
16—Spending the designated endowment, with legal sanction
17—Borrowing from banks to meet a chronic budget deficit, or to repay past debts
18—Merging as an alternative to bankruptcy
19—Closing the college partly, then completely
20—Selling the assets to satisfy creditors

Vincent A. Fulmer, who reviews Earl F. Cheit's study of the financial plight of colleges and universities, proposes this Depression Scale to interpret the financial status of an institution in terms of its financial practices. The Scale is intended to portray more visibly than most expositions of financial problems how a college can sink inexorably through the early stages of a 20-step process which ends in bankruptcy.

We have seen—and are due to see more—sporadic instances of college and university closings and bankruptcies. Less obvious but very real is a growing number of cancelled programs, schools, and departments—dramatic events for higher education. Mr. Cheit would classify institutions forced to take these steps as "in trouble." But what really is "trouble"?

It is a curious paradox of our time that most profit-making enterprise is regarded as unfit for survival if two or three consecutive years of losses are experienced—whereas a college might have a deficit for several years running and still be regarded as a shining jewel. That is because colleges are not supposed to make profit in our society. Yet the bald fact is that no college, public or private, can long sustain a deficit. Indeed, if a college does not realize

enough revenues from all sources to pay its bills and add enough to its endowment or physical plant so that its capitalization does not suffer, it may be losing ground—as most colleges have for the past several years. The corrosive effects of deterioration in quality that accompany financial stringency and which can be seen but not measured throughout higher education today are vastly important for the future of universities and of the nation.

In his study, Mr. Cheit admits that he had to ask the institutions how they felt about their financial condition to develop his classification scheme. He acknowledged that he and his staff finally had to make difficult value judgments. In the end, he based his criteria of financial health on the absolute maintenance of the total program and mission of each institution studied as a measure of whether and how far its quality had been affected by financial strains. For research-oriented universities with high program obsolescence or for others with heavy commitments to public service, these criteria pose inherent problems.

Inspired by Mr. Cheit's effort, this reviewer now proposes instead a simple sliding scale—the Depression Scale—which might be said to indicate the severity of the financial shock wave impinging upon a college treasury, to show the financial plight of a college in terms of its financial practices. The higher the index the healthier the college treasury, the lower the index the greater the college's trouble.

This Depression Scale can be both an indicator of moves open to a college in its struggle for financial survival and an indictment of an institution which may have gone further down the Scale than it has been willing to admit to itself or to its constituents. The Scale reveals that what begins as a stop-gap measure in one year of deficit may simply become a convenient point of departure for the next step towards financial suicide.

While there may be differences among college treasurers in the detailed order of the Depression Scale chronology, there is no denying that once the financial snowball begins to roll downhill in the form of sustained operating deficits, it will accumulate and gather speed and before long will be unstoppable. In the end it becomes a Failure Scale.

If the endowments of higher education have long since ceased to provide a major source of income for the operating budgets of the nation's colleges and universities, their usefulness as a financial cushion against snowballing deficits should be seen for what it is—a slender insurance policy against ultimate financial collapse. It is precisely because this possibility is so unthinkable by lawmakers, donors, and academics alike that our colleges and universities are in jeopardy of their financial lives.

The Depression Scale runs from the exhaustion of reserves to the spending of capital, to borrowing, and—finally—to bankruptcy and failure. It runs numerically from 1 to 20, with every other step a new form of capital incursion. The reader can ask himself where his college

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is now, and he may discover the fact that many colleges are resorting to several of these moves simultaneously.

If the Depression Scale can help to clarify the progression of financial decline in a given institution, as the drought in higher education continues, or to make institutional comparisons, then it will be worth the time and effort to apply it. It is a sad and perhaps irremediable fact, which Mr. Cheit adequately documents for 41 American colleges and universities, that many if not most institutions in the U.S. are already half way down the Depression Scale.

No nation in recorded history has cared as much about its youth or invested more than has the U.S. in its pluralistic system of higher education. The man (or woman) who will be elected President in the year 2000 may be in next year's graduating class. Can we as a nation afford to let that college education be second rate?

Letters

Continued from p. 5

grams, for example, favor gas cooling instead of liquid metal."

The above sentence is very misleading, for it could give uninformed readers the impression that the U.S. program is out of step with European scientists by pursuing LMFBR technology to the disregard of gas breeder technology. The one word to best describe our LMFBR progress compared with that in Europe is "behind." Three European countries are building LMFBR's; I know of none building a gas-cooled breeder. The reasons given by the majority (not necessarily all) of fast reactor designers on both sides of the Atlantic are that past and present studies indicate an economic advantage for LMFBR's over gas-cooled breeders.

My point is not to advocate LMFBR's in preference to gas cooled breeders but to request a reasonable statement of the facts by either side.

C. L. Larson
Sunnyvale, Calif.

On Neurology, Physiology, Psychology, and Unicorns

In his review of *The Mind of Man* (*October/November, p. 86*), Robert Sanders is kind about the content of my book but skeptical about an assumption of brain research—that in principle mental experience is explicable in terms of brain mechanisms. He does not quarrel with the goal; nor does he say, with Chomsky, that our natural sciences are simply too weak to attain it yet; instead, Sanders says that there is at present a logical discontinuity between neurology and psychology. This issue is, of course, a philosophical minefield, but perhaps I can illustrate a point of view I found helpful in negotiating it.

As an instance of man's mental life, consider his invention of the unicorn. It is not a trivial example—the idea may have occurred to an anguished victim of schizophrenia, and surely could not have occurred to one of Skinner's pigeons. At the other extreme, the processing of visual information that enables us to tell a horse from a piano is the kind of thing that should be susceptible to neurological analysis. After all, cats and mere computers can learn to recognize things, and the cell-by-cell research of Hubel and Wiesel already takes us to the point where the animal brain picks out what is characteristic and durable among the confused images of a flickering eye.

Getting from the horse to the unicorn depends upon wonderful human machinery, but it does not clearly involve any process inconceivable to physiology. It requires a capacity for reconstructing and recombining visual impressions of horses, bulls etc., and for feeding the products back into machinery responsible for evaluating the appropriateness of an idea, to judge whether the combinations are useful or meaningless. I see no reason why this evaluating system should not be essentially the same as that which decides whether a real horse is docile or angry—and that, in turn, is no great extension of the ability to tell whether one is looking at his own horse or somebody else's. In brief, our mental activity is the adaptation, to a realm of thought, of machinery that we needed in the first instance to be clever hunting animals.

Incidentally, although you put the price of *The Mind of Man* at $0.00, the publishers and I had not intended such philanthropy. The price is $\infty/0 = \$8.95$.

Nigel Calder
Crawley, Sussex

Mr. Sanders responds:

The object of skepticism in my review of *The Mind of Man* is not at all the assumption that mental events can in principle be explained as brain processes. The assumptions I believe to be wrong are that the explanation is currently under way, and that more physiological facts promise further elucidation of psychological phenomena. My claim is that physiological psychology must *begin* with profound revisions of both mental and physical descriptions, but this is certainly not to claim that such revisions are impossible and hence that physiological psychology is impossible.

Getting from the retinal image of a horse to visual recognition of a horse is presently no more understood in physiological terms than is getting from perceptions of horses to fantasies of unicorns.

Particular orientations of light or dark edges are not characteristic of any visual object and are not durable in the sequence of retinal images that objects present to us. The response of cortical units to these patterns is not the physiological equivalent of visual experience; surely some formidably abstract relationships among their responses lie closer to what we would call visual experience, but an understanding of these latter processes is so remote that we now have no guess as to why visual cortical cells select this sort of stimulus.

Identification Corrected

In "The Killian Years and M.I.T." (*July/August, 1971*) you publish a photograph (*p. 16D*) showing James R. Killian, Jr., '26, receiving Pandit Jawaharlal Nehru, Prime Minister of India, and Mrs. Vijayalakshmi Pandit, Nehru's sister. The caption for this picture states that Dr. Killian is receiving the Prime Minister and Mrs. Nehru, which is incorrect.

Srinivasa Murlhy
Cambridge, Mass.

Runnymede—Another View

Though I wish to compliment my alma mater in turning out a young man who can express himself so effectively as Steven C. Carhart (*"Hobnobbing with the Establishment," May, 1971, pp. 92-94*), I cannot read the article without replying to what I consider fallacies in his thinking.

One can hardly blame the young men of today who find it distasteful to be drafted to fight in what appears to be a political war in a distant, undeveloped country with little apparent effort for a decisive victory. But one who starts at the beginning will realize that North Vietnam, after beating the French, had an effective and powerful army. Whether motivated by religion or nationalism, North Vietnam decided to infiltrate and impose its communistic rule on South Vietnam. Having been a party to the birth of South Vietnam, and in our self-assumed role of protector of independent countries, we lent our aid, increasing it as North Vietnam increased its pressure.

The policy pursued by President Nixon is to build up the military and industrial power of South Vietnam to the point where that nation can defend itself. This is working so well that we have been able to withdraw over half our men since President Nixon took office. Most thinking people feel that this is the only honorable way we can withdraw without jeopardizing the South Vietnamese. North Vietnam could stop the war immediately by calling off its invasion of South Vietnam, Laos, and Cambodia. But the "doves" and communistic media have little to say about Hanoi's responsibility in this respect.

Mr. Carhart states that we are destroying these countries, when actually their advancement will be accelerated by at least one generation as a result of their increased know-how and the physical improvement of seaports, airports, roads, hospitals, schools, and industrial facilities which we have accomplished and will leave behind us.

I am certainly not an advocate of continuing the Vietnam war any longer than necessary. We went into it with honorable intentions, and I resent the persistent communist line that we are a power-thirsty aggressor with no soul when the aggressor in fact is Hanoi.

William W. Upham, '23
St. Petersburg Beach, Fla.

M.I.T. in Politics

Politicizing of the Institute proceeds apace, and I am sure the alumni will oppose it when they come to realize what is happening. Active participation in partisan politics is occurring in many American universities, particularly in the "liberal" Northeast. It is the major cause of the problems in which universities now find themselves, and the churches are in trouble for the same cause.

Here are some examples at M.I.T. Two years ago, radical professors, students, and outsiders initiated an attack on defense research at the Institute, with considerable success. In the May issue of the *Review* the President of the Class of 1970 parrots the hate-Nixon ("no matter what he does") and anti-war propaganda of the liberal politicians and the socialist-Marxist professors. There are plenty of these latter at the Institute, judging by their publicized activities.

Youths in fear of risking their skins in the armed services are very susceptible to such influences. Interestingly enough, the activist anti-war (and usually also anti-capitalist) youths are nearly all to be found at colleges—they are not young people earning their living in the mainstream of American life. It is pretty obvious that in colleges youths get a very one-sided picture of the world. I wonder how many of their professors would be fired if there were implementation of the 1940 statement of the American Association of University Professors, which is still supposed to control teaching of controversial material.

Each month the newspapers bring new evidence of M.I.T.'s involvement in politics—an anti-war biology professor visits Hanoi to "look at their research;" a Senior Research Associate of the Institute's Center for International Studies turns over stolen secret Pentagon documents to the liberal press.

What has happened at this great Institute to the "scientific approach," which calls for dispassionate appraisal of the pros and cons of all questions, be they scientific, political, or moral? In view of our new President's past record for political activism, the present trend can only be reversed by heavy pressure from the alumni to return M.I.T. to its original purpose—namely, the development and training of engineers and scientists, not politicians.

A. Donald Green, '26
Westfield, N. J.

Politicizing M.I.T.

Phooie—pages 72 and 4, January issue. Dr. Wiesner is seduced into a public approval of political acts by President Nixon, and the Editor of the Review assures his readers that scientists and their institutions must have special roles in the political arena. Wrong! Wrong! Wrong! M.I.T. has been diminished as it has become politicized.

Robert A. Farquhar, '49
Woodhaven, N.Y.

Leader's Responsibilities

My congratulations to the man who wrote the heading, "A Stockholder's Responsibilities" for the story of M.I.T.'s voting its 202,960 shares of General Motors stock (*Trend of Affairs, July/August, p. 60*). But what a pity that head could not have read, "A National Leader's Responsibility"—and have been just as appropriate.

J. W. Rockefeller, Jr.
Elizabeth, N.J.

Concealing the Nature of the War

In Trend of Affairs for December (*"Instant Science," pp. 73-74*) you say that the Cambodian Kouprey is a threatened bovine species because the cattle are in an area of Cambodia "'overrun with Vietcong'" and the Cong "have a great fondness for beef."

It is remarkable that you can make such a statement when "the United States is now waging a full-dress air war across Cambodia" (*Washington Post, January 21, 1971*). "Numerous towns and villages have already been decimated" (*Washington Monthly, July, 1971*) in an air war that has seen the U.S. drop more than 13 million tons of explosives, more than in all of World War II, on Indochina. This is a far more likely cause of the decline in cattle population than the one you claim. Inaccurate and snide reporting like this example is one of the reasons the U.S. government has been able to conceal the nature of the Indochina War from the U.S. public for so long.

Ethan Signer
Department of Biology, M.I.T.
Cambridge, Mass.

The Review *found the item of interest as a rare allegation of "ecological" damage by America's opponents in Southeast Asia. Environmental damage by U.S. forces is, of course, well known and has been fairly well covered in the Review in previous issues.*

An Evaluation of Value

The first question of the Commission on M.I.T. Education ("What can be done to improve our definition of knowledge so that it does not automatically exclude questions of purpose?"—*page 92 of* Technology Review *for January, 1971*) is well posed and possibly equally well answered. In the fourth annual report (1967-68) of the Harvard University Program on Technology and Society, Emmanuel G. Mesthene writes:

"We have found it most useful to define technology as tools in a general sense, including machines, but also including linguistic and intellectual tools and contemporary analytic and mathematical techniques. That is, *we define technology as the organization of knowledge for practical purposes* (italics added). It is in this broader meaning that we can best see the extent and variety of the effects of technology on our institutions and values."

In other words, what we can do in direct answer to the question is to create a meta-definition of knowledge so that it includes practical purpose. When we do this we have Dr. Mesthene's very useful definition of technology.

If his definition helps him see the extent and variety of the effects of technology on institutions and values, will not this same definition aid M.I.T. in answering the Commission's well-phrased question?

Robert Copsey, '44
Los Angeles, Calif.

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Paul E. Schindler, Jr., '74
News Editor, The Tech

On Being President of M.I.T.

Here is an account of Jerome B. Wiesner's day by a student assigned for The Tech to spend it with him. When evening came "he looked tired and I felt exhausted."

At 6 or so each morning, while the vast majority of the 7,000 people in the M.I.T. community are still in bed, Jerome Wiesner gets up and starts his day. Some mornings, he will head right for the airport; other days, such as Wednesday, December 16, 1971, he spends in Boston, Cambridge, and his home, Watertown.

There is no such thing as a typical day in the life of Jerry Wiesner. Every day holds something out of the ordinary for the president of America's foremost technological institution. His roles as administrator, public figurehead, fund raiser, and private individual of taste and distinction dictate an ever-changing pattern. Through several hours of discussion and careful planning, arrangements were made for this reporter to follow Jerome Wiesner through an entire day, from breakfast to bedtime. What follows is an attempt to blend that information with that from many other days, to get an idea of just what it is that Jerry does for a living.

The Tech's day with Jerry Wiesner began at 8:15 a.m., when this reporter arrived late by a quarter-hour for breakfast (streets are as well marked in Watertown as they are in Boston, and Wiesner lives on a side street off a side street at the top of a hill). Bryndis, the Wiesners' black labrador, was there to greet me when the door was opened.

In a way, Bryndis is typical of the Wiesner home and possessions. The home is not a mansion, but it is large and well kept, and in an outstanding hilltop location in the midst of a suburb-size lot. The house was "lived-in" clean inside; it was no museum (especially the desk top in Wiesner's den), but it showed attention and care. The Wiesners have lived in this same house for about 20 years; they moved into it not too long after he began work for the Research Laboratory of Electronics and decided to stay there when he was elected President. (Jerry relates a story of their first week in the house: the water heater broke down. Careful inspection revealed the fault to be in some copper tubing which he removed, took to R.L.E., repaired and replaced. The Wiesners draw hot water from the same heater today.)

The first event of the day in his office at M.I.T. is coffee, brought to President Jerome B. Wiesner by his Administrative Assistant, Miss Barbara Wollan. Then comes a review of the day's calendar—and the beginning of the business of communications. "The phone rings an awful lot around here," Dr. Wiesner told Paul E. Schindler, Jr., '74, during the latter's day of following the President's job for The Tech. *(Photos: Paul E. Schindler, Jr., '74)*

It was a surprise to find everyone so wide-eyed and bushy-tailed upon my arrival. If Dr. Wiesner is not going out of town in the morning, he is up at 6 and in his den reading long papers brought home from the office, thinking or writing until about 7:30.

The Wiesner housekeeper prepares breakfast: coffee, scrambled eggs, bacon, and English muffins for this particular morning. *The New York Times* was on the table, but Wiesner had either already read it or would look at it later. During breakfast, he talked with Mrs. Wiesner about little things—family plans, the upcoming evening, a call yesterday from Dr. Killian's secretary about a fund-raising trip.

On Getting from Point A to Point B

If his schedule includes a night-time engagement immediately after office hours, Dr. Wiesner will drive himself to M.I.T. (His alternative would be to ask for the M.I.T. driver. Arrangements for this mode of transportation are usually made a day in advance, as this one car has many masters to serve in the upper-

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This account of "how Jerry Wiesner runs the Institute" first appeared in The Tech, *from which it is reprinted by permission. Mr. Schindler, who came to M.I.T. from Portland, Ore., is studying in the Sloan School of Management.*

Dr. Wiesner's day begins at 6 in the morning—and often ends more than 18 hours later—at this desk in his Watertown, Mass., home. Paul E. Schindler, Jr., '74, reported in The Tech *that the Wiesner house ("especially the desk top in the den") was no museum; the house, he said, was " 'lived-in' clean."*

echelon levels of the M.I.T. administration.)

Wiesner talks like someone who has regularly driven to work himself for a long time, as he watches the traffic on both the Boston and Cambridge sides of the river to keep track of the pattern. "It's usually best to take the Cambridge side early and the Boston side late," he noted. But we were "late," and traffic was bad on both sides, so it was a toss-up.

Wiesner has a casette player in his car and a collection of classical music casettes (mostly Deutsche Grammaphone) which he prefers to the radio. As he listens, he hums the theme to himself, slightly ahead of the tape. But today, the F-M side of his A-M/F-M car radio was tuned to WCRB.

Jerome Wiesner, the Man

He drives in through the arch by the infirmary and parks in the inner courtyard, in a reserved yet nondescript parking place. There are no signs on it saying "President Only." "Some people need that kind of thing, but I don't—just as long as I have a parking place." From there, it is only a 50-foot walk to the shelter of a building, which makes the Wiesner parking spot rank as one of the most convenient on campus.

When he walks through the halls of M.I.T., he has a smile for all, a nod, sometimes a wink and always a greeting for those he knows, and a moment for anyone who wants to stop and chat. Questions usually bring answers; complaints often bring action.

Other executives may be going mod, but extra wide ties and wildly colored shirts are not the standard for Wiesner. Paul Gray may occasionally be seen in something "tastefully colorful," but the President prefers dark suits, quiet shirts, and conservative ties. His coat stays on during the working day for the most part, except when he shaves in preparation for a long evening in public, as he did this day.

His pipe really does seem omnipresent: he smokes four pipes in his office before lunch and puffs smoke rings during meetings, as he looks at the principal speaker's ear (about all he can see from his usual vantage point).

As he looks out at the audience, his glance moves casually from person to person and section to section. When it lights on certain people, he will smile and wink. Anyone sitting nearby feels the wink intended for him; it's great "theatre": most people beam and feel good.

Wiesner will occasionally pace while others speak, but always manages to seem attentive and proves himself so when he goes on to comment on the topic at hand. In fact, he does not like to sit in one place for a long time. He will seldom be at his desk for more than 10 minutes without getting up, or turning his chair around, or leaning back. He often rocks his chair slightly when he is on the phone, or will tap his feet and hum softly (the humming is rare and somewhat off-key).

He goes to the faculty club for lunch by car: the 15-minute walk is more time than he can, on most days, afford to lose out of a busy schedule. Today the weather is poor, so Mr. Gibbs drives us to a back entrance which minimizes the length of time spent in inclement weather. Wiesner does not melt if exposed to rain, however. In the evening, when he drives himself, he faces the same parking problems as anyone else, sometimes finding himself blocks away from where he is going. He drives conservatively for a long-time Boston resident.

Wiesner also flies a great deal—not a lot for an executive, but more than most people. A majority of his trips are to New York City and Washington, where he does work for M.I.T., the Sloan Commission on Cable Television or the government, or attends a board meeting. He travels first class, according to his secretaries, "because he works on the plane" and it's much easier to do paperwork in the front section than in the back.

Communications and Paper

Secretaries are the vital link between any executive and the rest of the world. Wiesner is no exception. Due to the size and complexity of his job, he has an Administrative Assistant (Miss Wollan), a secretary (Mrs. Hrbek), and a receptionist he shares with the Chancellor. They keep his phone, his plane tickets (and his theatre tickets for a night at *Man of La-Mancha* with Mrs. Wiesner), his calendar, his door, and in the final analysis his ear.

First thing in the morning they bring in coffee as he unloads his briefcase. They are prepared to recite the day's calendar for him, noting his first meeting, the status of lunch, and reminding him of a school board meeting that night. They answer the phone for him at all times—rare indeed is the occasion when you hear Wiesner's voice first if you call him at his office.

Every incoming phone call is carefully documented, with a note, a message, or an appointment as need be. The notes and messages are carefully kept in order of both time and importance and sent to Wiesner through the secretarial buffer. As he goes through papers at his desk, he and his secretaries take turns. They say, "Would you like to call Professor Smith back about that Jones thing?" Or, alternatively, he will say "Would you get me John Doe in Washington?"

The first work that Wiesner gets in the morning is the paper work generated in the last two hours of office work the day before—usually about two inches thick.

There are three major categories of file folder that appear on the presidential desk, time and again during the day: outside correspondence, M.I.T. correspondence, and "Dr. Wiesner's signature."

Outside correspondence includes drafts of letters to and letters from people outside of the M.I.T. campus. These include M.I.T. alumni, senators and congressmen, members of the business community, and potential contributors. This folder will also input any outside reports or analyses that arrive in the office which concern M.I.T., its function, or Dr. Wiesner's personal interests.

M.I.T. correspondence consists of letters and memos, as well as reports and information sheets from people inside the community. Either of these files is also likely to hold an occasional newspaper clipping of interest or a Xerox of a magazine article. (All the secretaries in the president-chancellor office suite are asked to read *Tech Talk* and all three student papers; several read *Technology Review* and *Tech Engineering News* as well).

The "Dr. Wiesner's signature" file probably gets the most careful scrutiny. It includes travel vouchers (any non-M.I.T. travel is paid for by the non-M.I.T. source involved), checks, and letters and memos (most of which he has prepared but some of which are news to him). Form letters for example, are an area of special concern. A form letter from the President's office is hand-typed, often with slight variations in the text that have to be watched. In addition, Dr. Wiesner is careful not to sign "Jerome B. Wiesner" to letters addressed to long-time close friends—these he signs "Jerry Wiesner."

Every piece of paper that comes to his office to which his secretaries attach the

slightest importance passes beneath Wiesner's eyes. The vast majority of it he skims lightly and puts into his "out" box (the box is cleared about five times a day, and each time it contains about six inches of paper) without note or comment. Some of it prompts him to write a brief note about an eventual reply.

A small percentage of the letters—and almost any material over three pages long—goes onto a pile on his right. Once or twice a day he gathers all of these materials up and places them in his briefcase, the source of his reading material in those early-morning (and occasional late-night) hours he spends in his den at home. Some of the "take-home work" comes back from home to the table behind his working desk, which serves as a kind of "paper buffer zone" with each drawer containing certain papers he may want quick access to.

"The Phone Rings an Awful Lot Around Here"

Wiesner has all sorts of calls, but they fall into two broad categories: "input" calls and "output" calls. Input calls are usually (although not always) initiated by the other party and consist of Wiesner saying hello and then being quiet for a long time. He will make occasional notes and usually concludes the call with a few pleasantries or plans for a face to face meeting at some future point. Output phone calls are usually initiated by a suggestion, either from Dr. Wiesner or one of his secretaries, and consist of a brief "Hi, how are you," followed by an organized presentation of the necessary information. (It is not written or outlined, but sounds as if it could be.)

Meeting People in the Office

Dr. Wiesner meets a lot of people face to face in his office during any one day. Most of them sit in a chair to his left and look across a brief expanse of granite.

For the most part, Wiesner just listens, offering an occasional comment, a question to clarify this point or that. If asked for an opinion, he will offer it; sometimes he will end an appointment with a suggestion or comment.

Not all the people who come into his office sedately sit down and quietly talk of their business, however. On this day J. Herbert Holloman, Special Assistant to the President, came in with news concerning possible future income for M.I.T. The secretaries waved him in, and he stood about ten feet from the desk and quickly filled Wiesner in. Then, just as quickly, he was gone. When asked, "Do you get good news very often," Wiesner replied, "Not often enough."

The Office of the President

Jerome Wiesner's office, to the left behind the big glass door, is a wood-paneled wonderland, bathed in the harsh blue light of a fluorescent ceiling.

The walls hold many photos including ones of John and Edward Kennedy, Wiesner's wife and daughter, and an excellent color photograph of the touching moment during the inauguration ceremony when Archibald MacLeish and Dr. Wiesner embraced. There is one piece of wire sculpture in the office, a unicyclist on a tightrope, sitting on the corner of the granite desk at which Wiesner works most of the day. Called "The Presidency," it was a gift from Wiesner to President Kennedy who used to balance little name tags on each end of the balancing pole, like "congress—constituency" or "D.o.D.—Soviets." After the assassination, Mrs. Evelyn Lincoln got it back for Wiesner. He tells the story behind it a couple of times a day (and if you ask, he'll tell you it doesn't apply to the M.I.T. presidency: "Unlike some places, we don't have those kind of antagonisms here.")

Lunch is not merely a time to eat, if you are President of M.I.T. There are a lot of people who want to see you every day, and it is almost unfair not to make better use of your lunch hour than merely eating. Besides, it is nice to have someone to talk to. So several minutes of the morning are spent sounding out various possibilities for lunch, until a dean is found, and then it's off to the Faculty Club. Lunch takes a leisurely hour, during which the stock of your knowledge is increased.

Wiesner seems to have the greatest amount of communication with two executives: Paul Gray, '54, Chancellor, who is the other half of the double yoke which the Corporation seemed to envision when they set up M.I.T.'s management structure for the 1970s; when the two get together, they usually do so in the hall, or in the central area between their offices, or in some other meeting they are both attending. There is an intercom from one office to another, but they prefer to meet face to face.

The other administrator closest to Wiesner is Constantine B. Simonides, Vice President, whose role seems to a degree to be that of briefing officer. He will sometimes handle requests for information that Wiesner and Gray do not have time to get to right away. He will troubleshoot, occasionally draft letters, and on this particular occasion came in to brief the President before the faculty meeting.

Even the President's Day Ends, Eventually . . .

Today, Dr. Wiesner worked in his office until 6 o'clock, when he met another professor, with whom he drove off to meet Mrs. Wiesner at the St. Botolph Club on Commonwealth Avenue in Boston.

Although the job of President may seem sedentary, there is something about it which, while not involving physical labor, still manages to tire a person. This reporter had had eight hours' sleep the night before he undertook this 14-hour assignment; Wiesner, it turned out, had slept only four hours the night before. By mid-afternoon both of us felt pretty tired, and by the end of the day, he looked tired and I felt exhausted.

But given the opportunity, if he gets home early enough, Wiesner likes to get a look at the late evening news before going to bed. He will often spend time in his den before retiring for the day, reading or thinking while puffing on the final pipe of the day. No matter whether he doesn't go to bed until 1:30 or 2 a.m. (as frequently), he is always up the next morning bright and early.

Institute Review

Inferno: A Grading Scandal

M.I.T.'s academic community was surprised this winter to learn that there exists a system of "hidden grades," which some fear threatens the integrity of the freshman pass/fail experiment. The discovery was made at the same time that the four-year experiment came up for final review.

The pass/fail program is the elimination of letter grades for freshmen, substituting a system under which students would (presumably) be recorded simply as passing or failing and receive from their instructors a private, personal evaluation.

The question surfaced when members of the Class of 1972—the first class to finish with a pass/fail freshman year on their records—applied to medical schools and were asked for transcripts of freshman grades. They found they could comply; Peter Buttner, '61, Assistant Dean for Student Affairs, explained that "grades are being informally generated by instructors or departments and sent to graduate schools at the students' requests.

"There is nothing illegal about this in the literal sense," Mr. Buttner says, "but lots of people feel that it is contrary to the spirit of the pass/fail system."

Will the intense competition for medical school admission, leading to the schools' insistence on grade reports from all applicants for all subjects, be the fatal flaw in pass/fail? No one thinks so, though Everett E. Hagen, Chairman of the Committee on Evaluation of Freshman Performance, admits that "no one now knows how serious the medical school problem is." Many feel that it would be ethical to use an expanded version of the written evaluations to support applications. Indeed, for the time being Bernard S. Gould, '32, Chairman of the Premedical Advisory Council, advises freshmen "to arrange for some kind of evaluation of your pass/fail."

Most members of Professor Hagen's committee favor a strong stand against "hidden grades," and the Student Committee on Educational Policy says it "assigns the highest priority to maintaining the integrity of the ungraded experience of the freshman year. . . . No formal method should exist to reconstruct a grade."

	Attitude toward pass/fail:		
	Positive	*Negative*	*Undecided*
Students, spring term 1971	81%	9%	10%
Freshman instructors, spring term 1971	57	23	20
Freshman advisers, 1968	55	15	30
Freshman advisers, 1969	59	11	30
Freshman advisers, 1970	65	11	24

The evaluation committee recommends that M.I.T. continue—and slightly modify—the pass/fail system which has been tested for freshmen during the last four years. It is popular with students, instructors, and advisers; and, says the evaluation committee, there is no systematic evidence that it has affected the attractiveness of M.I.T. to creative students. Problems created for pre-medical students seem to be resolvable.

Purgatorio: Grading Pass/Fail

Despite the problem with medical schools (*see above*), the pass/fail experiment appears to have met most of its goals. Now that the trial period is ending, an evaluation committee has recommended that the system be continued—and perhaps expanded.

"Freshman pass/fail has not done everything that was hoped when it was instituted," the committee chaired by Everett E. Hagen, Professor of Economics and Political Science, reported. But "it is popular with students and at least widely acceptable to faculty. There have been both anticipated and unanticipated benefits, and some disadvantages.

"Balancing the many discernible effects, we conclude that it should be regarded as a definite improvement to the freshman year," the committee said. It reported the following findings:

☐ Pass/fail has gained wide acceptance among students, teachers, and advisers (*see table*).

☐ Available information suggests that freshmen do, indeed, feel less competitive pressures to perform on demand—but not as much less as sponsors had hoped.

☐ Pass/fail has altered academic work patterns of freshmen in what appear to be beneficial ways. Many, though not all, freshmen recently surveyed reported that because of pass/fail they (1) explored more fields and took a more diversified set of subjects, (2) concentrated more on subjects that were personally interesting, (3) took harder subjects, (4) "bunched up their work," pursuing in depth an interesting topic while temporarily neglecting other work, and (5) became much less dependent on grades as an index of progress.

☐ Though some freshmen abuse the system by studying only enough to "get by," there is no firm evidence, overall, that students are learning less.

☐ The written evaluation system "is more beneficial than letter grades for those who make active use of it."

☐ Pass/fail has helped make possible new forms of education stressing greater flexibility, such as self-paced, modular subjects.

Paradisio: Towards New Systems

Drawing from the success of the four-year experiment, the Committee on Evaluation of Freshman Performance has recommended to the faculty what it calls the "logical extension"—pass/no record.

"A major difficulty with the pass/fail as it now stands," the Committee reports, "is the sharp discontinuity between pass and fail. Between the freshman who passes and the one who fails there may be only a small difference, yet the one who fails is penalized twice—he has no credit, and he has the F on his permanent record."

If "no record" were substituted for "fail," there would simply be no record; teachers would thus have more freedom to fail marginal students.

But in the longer range, the Committee recommends that the entire grading system be re-evaluated. "New modes of

School in which student received undergraduate degree (June, 1970):	Per cent of program taken in: School of Engineering	School of Science	School of Humanities	School of Management	School of Architecture	Other
Architecture*	13	24	20	—	**42**	1
Architecture**	7	11	13	1	**67**	1
Engineering	**41**	31	22	3	1	2
Humanities	9	30	**53**	2	3	3
Management	12	24	23	**37**	1	3
Science	8	**65**	22	2	1	2

* Four-year S.B. program
** Five-year B.Arch. program

M.I.T.'s is a heterogeneous academic community. This table shows the percentage of the units presented for graduation in June, 1970, by students in each school awarded in courses in each of the schools. For example, only 41 per cent of the academic work of engineering graduates in June, 1970, was taken in the School of Engineering.

instruction are appearing throughout the curriculum, in upperclass as well as freshman subjects. . . . And in many of them instructors have already been forced to abandon, often on an *ad hoc* basis, the canonical A-B-C-D-F grading system on a fixed number of units."

Undergraduate Education: Approving the Recommendations

After three months of outwardly lethargic debate, the faculty has adopted three proposals calculated by its Special Task Force on Education (*see* Technology Review *for January, pp. 77-78*) to substantially increase the effectiveness of undergraduate education at M.I.T.:

☐ To encourage in undergraduate education teaching programs "in which students and faculty members meet and work in contexts similar to that in which a faculty member carries out his own work and to that in which a student might expect to pursue a later career."

☐ To place in the hands of a Dean for the Academic Program the responsibility for the strength of undergraduate teaching and for supplying leadership in its further development.

☐ To create an Education Division to help increase M.I.T.'s contribution to educational theory and practice at all levels, both within and outside of the Institute.

Of the Education Division, Hartley Rogers, Jr., the Chairman of the Faculty who was also Chairman of the Task Force, said at the January faculty meeting, "This will constitute a significant change both in the way in which M.I.T. appears to itself and also to the outside world. In the future, in certain areas of educational innovation and reform, people will look to M.I.T. as they now think of it for communications and computers."

Many observers felt that the faculty's reception was apathetic and its discussion somewhat irrelevant. Joseph L. Kashi, '72, wrote in *The Tech,* " 'Greater research contact' and 'coordinated undergraduate education' are hollow slogans without faculty enthusiasm."

But Professor Rogers refutes this view. He says that the issues had serious discussion in the faculty's committees, and the function of faculty meeting action "is not so much to carry on a full debate as to make sure that all of the issues have been addressed in the committees."

Student reaction to the debate was small, and few students seemed to care. Another who did comment, Alex Makowski, '72, suggested in *The Tech* that the recommendations do not go far enough.

Under the first recommendation, it is proposed that each undergraduate spend up to 25 per cent of his time working with a faculty member in some context other than the normal classroom relationship. Peter S. Eagleson, Sc.D.'56, Head of the Department of Civil Engineering, calculated that if half the undergraduates in that Department opted to use one-fourth of their time this way, they would in just these activities be commanding nearly 10 per cent of the faculty's total teaching time. Others joined him in wondering whether existing resources would in fact make possible the proposed program.

This question will be resolved during the spring, when the Committee on Educational Policy receives from each department views and data on how it can and should redistribute its undergraduate teaching efforts.

Questions of how the new Dean for the Academic Program would relate to existing administrative structures dominated the debate on the Task Force's second proposal. Several speakers felt that the new post could not be effective unless its occupant had considerable "clout"—and that means budgetary power. The Committee on Educational Policy agreed: "No matter how impressive the man, he cannot be expected to accomplish much on the strength of knowledge, experience, and moral suasion alone."

Speaking at the winter meeting of the Alumni Fund Board shortly after the faculty action on the Task Force recommendations, Paul E. Gray, '54, Chancellor, put them in the context of trying to bring "the immense resources of the Institute" increasingly into the service of undergraduate students. It is those resources, he said, which should distinguish an M.I.T. education.

Documenting the Change In an M.I.T. Education

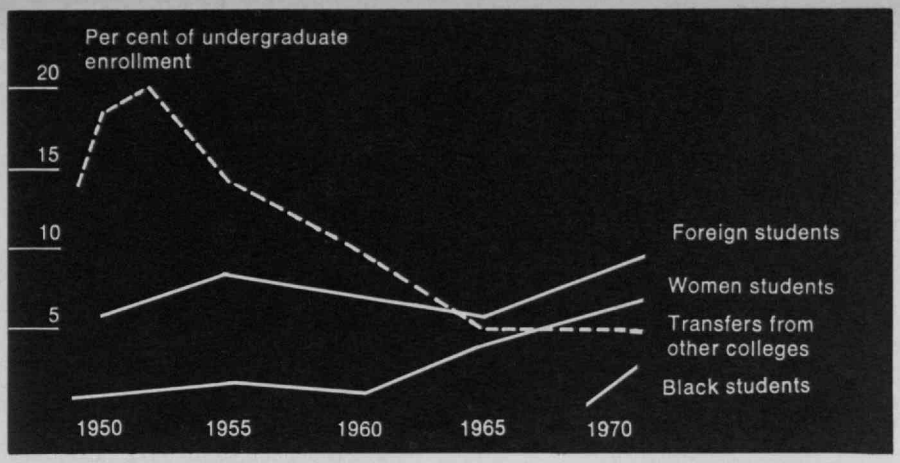
As the Commission on M.I.T. Education undertook its tasks in 1969 and 1970, there accumulated an unprecedented file of statistics about the Institute. The result, now assembled in a volume of "Facts About M.I.T." by Wayne A. Stuart, '59, would credit an actuarial office.

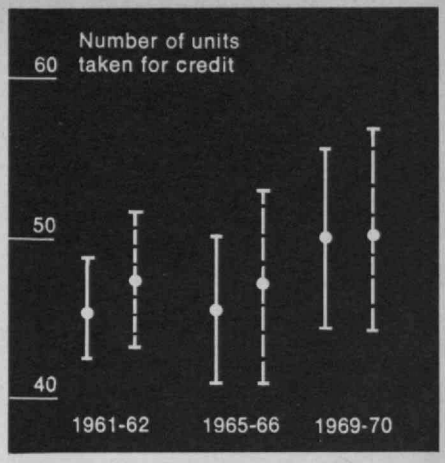
Though most of its data have been published elsewhere—and many in their present context—"Facts About M.I.T." provides some new perspectives on M.I.T.'s teaching enterprise and documents with rather remarkable statistics some common contentions on the changing patterns of an M.I.T. education:

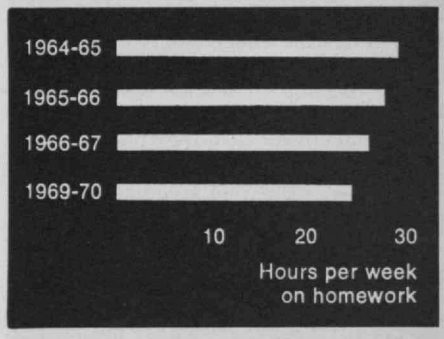
☐ Undergraduate students are following more different programs and a wider range of electives than ever before. In the first term of 1969-70, 72 per cent of the subjects taken by freshmen were to satisfy basic requirements; in the second term only 51 per cent. Meanwhile, the freshmen also enrolled in computer courses (7 per cent in the first term, 13 per cent in the second term), seminars (9 and 6 per cent), and other science subjects (4 and 13 per cent). In all, the freshmen in 1969-70 sampled 44 subjects in the first term, 88 in the second. Sophomores in the second term of that year were in 159 different subjects.

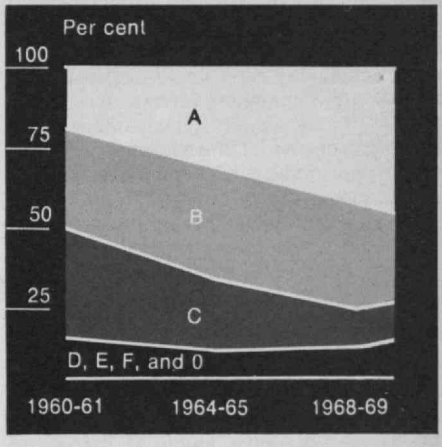
☐ Students are entering M.I.T. with better preparation than ever before; almost half of the freshmen received college-level credit for some high school work in 1969. Yet M.I.T.'s is an increasingly diversified student body (*see chart*).

☐ More undergraduates are continuing through M.I.T. to graduation—and in the field of their original interest which they named in applying to the Institute—now than in 1958. Just over 30 per cent of the undergraduates who entered M.I.T. in the Class of 1958 had left the Institute









M.I.T. undergraduate enrollment has slowly diversified in the last two decades—the numbers of both foreign students and of women rising modestly; the number of black students, insignificant before 1969, has risen sharply in response to the Institute's special efforts to make its resources available to minority students. Meanwhile, an increasing proportion of the entering freshmen have continued to complete undergraduate degrees—and so the numbers of students transferring from other institutions has perforce declined.

Freshmen are busier—registered for more units of credit—than ever before; the solid lines indicate the range for freshman registrations in their first term, the dashed lines in their second term (top). They report spending fewer hours on homework (center). Yet the percentage of A's given to undergraduates—before the advent of pass/fail grading—continued to rise.

before the end of their eighth term; of the Class of 1968, less than 20 per cent left.

☐ Students who do well in their first year at M.I.T. tend to end up majoring in physics and mathematics, those who are low first-year performers in engineering or non-technical fields.

☐ Recent M.I.T. undergraduates are registering for more credit hours per semester, working fewer hours on homework, taking fewer final examinations, and getting higher grades than their predecessors of a decade ago (*see charts*). Pass/fail grading for freshmen, started in 1968-69, has made current evidence on some of these questions hard to obtain—but seems to have had no significant effect on class attendance or on upperclass grades.

☐ The average M.I.T. undergraduate earns one-third of his academic credits in classes with enrollments of 100 or more and 25 per cent in classes of 30 to 100; the rest he earns in small classes (less than 30 students) and in individual study, including thesis (at least 16 per cent).

☐ The Schools of Architecture and Planning and of Science are the most self-sufficient, in the sense that graduates in these schools receive most of their academic credits toward their degrees within their own schools. June, 1970, graduates in the Schools of Science and of Engineering took 22 per cent of their work in the School of Humanities and Social Science. Engineering graduates took a good deal of science (31 per cent of their credits) while science graduates took very little engineering (3 per cent) *(see table on opposite page).*

Corporation Election

Over 6,000 recent graduates and members of the present senior class have been asked to help select one of their number for a five-year term as a "Representative from Recent Classes" on the M.I.T. Corporation. Already their suggestions are before a screening committee, and six names will be chosen by that committee to appear on a ballot reaching alumni eligible to vote early in the spring.

The "Representatives from Recent Classes" category of membership on the M.I.T. Corporation was created in 1971, and five such members were chosen a year ago for terms ranging from one to five years. The new member elected will replace Laurence Storch, '71, whose term expires on June 30.

Those eligible to vote—and from whose number the new Corporation member will come—include the Classes of 1972, 1971, and 1970, as well as all those receiving graduate degrees from M.I.T. in June, 1972, and in the previous two calendar years.

Suggestions are now being screened and the ballot assembled by a committee including James A. Champy, '63, Ralph M. Davison, '66, Chairman, James A. Hester, '65, Michael V. Sawyer, '71, and Mr. Storch; they are chosen as the five youngest members of the Corporation. The successful candidate of the six which they nominate will be proposed by the committee for election to membership on the Corporation at its annual June meeting.

In a special statement to the M.I.T. community, the screening committee pledged that its selection of nominees would be based entirely "on individual merit." Successful candidates, they said, will not be chosen as representing "any specific constituency"; instead, the selection will rest on the committee's "judgment in a broad sense of who might be most effective as potential Corporation members."

A Shareholder's Responsibility

When this spring's season of shareholder meetings and proxy issues opens, M.I.T. hopes to be better prepared than in the past to deal with the public-interest issues which will surely be raised.

A special committee representing students, faculty, staff, alumni, and the corporation began last January to prepare itself to advise the Corporation Executive Committee on both general policy and specific issues involving M.I.T.'s stock. It grew out of a summer study on shareholder responsibility headed by Professor Edward H. Bowman, '46; the Corporation Joint Advisory Committee on Institute-Wide Affairs proposed its specific composition and objectives.

The committee identified six issues for discussion at its first meetings:

☐ the question of corporate democracy

and shareholder participation,

☐ the question of disclosing corporate data that relate to public policies and social responsibilities,

☐ the question of investments in southern Africa and in other areas where discrimination is a national policy,

☐ the whole broad domain of ecological and environmental questions relating to business activities and industrial processes,

☐ concerns about industrial and product safety, and

☐ the issues of consumer protection, including deceptive advertising.

Mr. Walter L. Milne, who is Assistant to the Chairman of the M.I.T. Corporation and who provides staff support to the committee, feels that the most important shareholder issue this year will be dealings in southern Africa. Among the questions which the committee has discussed are, should M.I.T. act or abstain on proxy issues relating to African activities, and should American corporations withdraw from southern Africa or remain and try to change conditions there? A group of agencies of protestant churches plans to pursue the African issue in seven or eight corporations this spring.

In another of its early meetings, the committee heard a report from Dan Fenn, lecturer at the Harvard Business School, on the history and "state of the art" of assessing a corporation's public-benefit activities.

In the past, explained Mr. Milne, M.I.T. has responded to social-responsibility issues with "comment, letters, and [statements of its] views." It has mailed, for instance, copies of the Bowman committee's report to about 50 companies. But in every case, though it has liberally expressed its qualifications on proxy issues, M.I.T. has voted with management. What it will do this year is yet to be seen—but it will at least be better prepared to address the issues.

A Consortium Approach To New Financial Policies

A new, cooperative study of the rising cost of higher education and ways in which it may be met will be conducted by a consortium of nine East Coast universities—including M.I.T.—under a $310,000 grant of the Alfred P. Sloan Foundation.

John G. Kemeny, President of Dartmouth College, said the program, growing out of "the crisis in higher education brought about by rising costs, expanding program demands, and decreasing sources of financial support," will try to help all universities "examine their plans for financing the educations they provide."

He hopes the study may "ultimately make possible a multi-institutional program to meet the problem of financing undergraduate college education."

Paul E. Gray, '54, Chancellor of M.I.T. who represents the Institute on the consortium's policy board, was more specific. One of the goals of the study, he told *The Tech*, is "creative proposals for new modes of financing a college education." Other subjects of concern, he said, would include the relationship between cost of education and tuition charges and the effect of student financial aid policies on the cost of education and the ability of students to pay.

Noting the advantages of the consortium approach, Dr. Gray pointed out that the introduction of a new system of financing is likely to be more favorably received "if it is done by more than one institution." And, he said, the cooperative approach may make possible "a single joint financial aid and loan program drawing upon larger capital resources than any single institution could obtain."

Participating with M.I.T. and Dartmouth in the consortium will be Amherst, Brown, Harvard, Mount Holyoke, Princeton, Wellesley, and Wesleyan.

Good News for Graduate Students

Graduate students received a very welcome Christmas present from the Institute this year: Their theses may now be submitted on any heavy white bond paper, and any correction method may be used, provided clarity and legibility are not impaired. Formerly, theses had to be prepared with no corrections of any kind; the old rule was to insure that no changes could be made in library copies after the degree had been granted.

The reason for the change is simple: M.I.T. now stores archival copies on microfilm rather than in bound volumes. Less shelf space is used and subsequent changes are impossible. Dean of the Graduate School Irwin Sizer gives credit to the Graduate Student Council for suggesting the change, and he estimates that it will save the average student about $75.

And though he did not mention it, another benefit might be to restore a little faith in technology's ability to serve mankind.

The Coop's Best Sellers

Curious to learn what it could about M.I.T. by learning what it reads, *Technology Review* this winter asked Richard Hinman, Manager of the Book Department of the Tech store of the Harvard Cooperative Society, what are his best-sellers.

As of mid-February, they were the following, he said—a list excluding textbooks, given in alphabetical order:

Hardbound:

Cruso, *Making Things Grow* (Vol. II)
Forrester, *Industrial Dynamics*
Forrester, *Principles of Systems*
Forrester, *Urban Dynamics*
Forrester, *World Dynamics*
Goodman, *After the Planners*
Monod, *Chance and Necessity*
Skinner, *Beyond Freedom and Dignity*

Paperback:

Burgess, *Clockwork Orange*
Castaneda, *Separate Reality*
Heinlein, *I Will Fear No Evil*
M, *The Sensuous Man*
Niven, *Ringworld*
Toffler, *Future Shock*

What does this say of M.I.T.'s reading habits? Beyond the obvious interest in technically-oriented titles, the Coop's experience suggests to Mr. Hinman that people here "tend to use their leisure reading for recreation more than for furthering their interests." That shows up especially in paperbacks, where science fiction sells in "vast quantities."

Special Summer Programs 1972

Over 40 Special Summer Programs in fields of current scientific, engineering, and management interest ranging from transportation systems to enzymes will be given during the summer of 1972 at M.I.T. Tuitions for the one-, two-, and three-week courses range from $350 to $800, and further information is now available from James M. Austin, Director of the Summer Session.

Programs scheduled for 1972 include:

Biomedicine, Bioengineering, and Health Sciences

Biological Effects and Medical Applications of Non-Ionizing Radiations, Dr. Padmakar P. Lele, Associate Professor of Experimental Medicine, and Allan D. Pierce, Associate Professor of Mechanical Engineering, July 31-August 11, $550.

Biomedical Physics and Biomaterials Science, H. Eugene Stanley, Assistant Professor of Physics, June 19-23, $350.

Enzymes and their Use in Analysis and Clinical Diagnosis, Samson T. Jacob, Assistant Professor of Physiological Chemistry, and others, July 10-14, $350.

Physical Aspects of Nuclear Medicine, Gordon L. Brownell, Professor of Nuclear Engineering, July 24-28, $350.

The Dynamics of Health Service Systems, Edward B. Roberts, Professor of Management, August 21-25, $400.

Chemical Engineering

Modeling, Simulation, and Optimization of Chemical Processes, Lawrence B. Evans, Associate Professor of Chemical Engineering, June 21-30, $475.

Civil Engineering and Building Construction

Analysis and Design of Transportation Systems, Parts I and II, Wayne M. Pecknold, Assistant Professor of Civil Engineering, and Marvin L. Manheim, Associate Professor of Civil Engineering, August 14-18 and 21-25, $350 each or $550.

How Plastics Break, Frederick J. McGarry, Professor of Civil Engineering, July 31-August 4, $350.

Fundamentals of Earthquake Engineering for Buildings, Robert V. Whitman, Professor of Civil Engineering, June 19-23, $350.

Systems Building and Industrialization in the U.S., Albert G. H. Dietz, Professor of Building Engineering, June 26-30, $350.

Decision-Making and Statistics

Decision-Making Under Uncertainty: Models and Applications, Ralph L. Keeney, Assistant Professor of Civil Engineering, and Alvin W. Drake, Associate Professor of Electrical Engineering, August 21-September 1, $650.

Design and Analysis of Experiments in the Physical, Medical, and Industrial Sciences, Harold A. Freeman, Professor of Economics, June 19-30, $550.

Economics

Applied Urban Economics, Ronald E. Grieson, Assistant Professor of Economics, August 21-September 1, $550.

Electrical Engineering

Design of Synchronous Machinery Using Superconducting Field Windings, James L. Kirtley, Assistant Professor of Electrical Engineering and others, July 31-August 4, $350.

Detection, Estimation, and Modulation Theory, Parts I and II, Harry L. Van Trees, Jr., Professor of Electrical Engineering, and Donald L. Snyder, Assistant Professor of Electrical Engineering, June 6-10 and 12-16, $350 each or $600.

Digital Signal Processing, Alan V. Oppenheim, Associate Professor of Electrical Engineering, June 21-30, $475.

Image Enhancement: Coding and Recognition, Thomas S. Huang, Associate Professor of Electrical Engineering, August 14-18, $350.

Computer-Aided Linear Circuit Design Using

MARTHA, Paul L. Penfield, Jr., Professor of Electrical Engineering, and Donald H. Steinbrecher, Associate Professor of Electrical Engineering, July 5-14 or July 19-28, $600.

Environmental Engineering and Science
Engineering Aspects of Heat Disposal from Power Generation, Donald R. F. Harleman, Professor of Civil Engineering, June 26-30, $350.
Noise and Vibration Control, Leo L. Beranek, Lecturer in Electrical Engineering, July 30-August 5, $400.
Methods of Observation and Analysis of Harbor and Coastal Pollution, Erik L. Mollo-Christensen, Professor of Meteorology, June 19-23, $350.

Management
System Dynamics—Models for Policy Design of Industrial Urban and Environmental Systems, John Henize, Assistant Professor of Management, June 6-16, $800.
New Horizons in the Management of Change and Organizational Development, Edgar H. Schein, Professor of Organizational Psychology and Management, and Richard Beckhard, Senior Lecturer in Management, July 30-August 4, $650 (including accommodations and meals at M.I.T. Endicott House).
Models for Financial Management, Gerald A. Pogue, Associate Professor of Finance, and Stewart C. Myers, Associate Professor of Finance, July 17-21, $500.
Basic Concepts in Financial Management and Strategy, Gerald A. Pogue and Stewart C. Myers, July 10-14, $500.
Management Science in Marketing: Building and Implementing Models, John D. C. Little, Professor of Operations Research and Management, and Glen L. Urban, Associate Professor of Management, August 14-25, $800.
Management of Research, Development, and Technology-Based Innovation, Edward B. Roberts, Professor of Management, June 19-30, $800.

Mechanical Engineering
Strain Gage Techniques, William M. Murray, Professor of Mechanical Engineering, July 10-14, $350.
Industrial Photoelasticity, William M. Murray, June 12-16, $350.
Modern Developments in Heat Transfer, Warren M. Rohsenow, Professor of Mechanical Engineering, and Peter Griffith, Professor of Mechanical Engineering, July 17-28, $550.
World-Wide Trends in Welding Technology, Koichi Masubuchi, Professor of Naval Architecture, July 17-21, $350.

Nuclear Engineering
Nuclear Power Reactor Safety, Parts I and II, Norman C. Rasmussen, Professor of Nuclear Engineering, July 10-14 and 17-21, $375 each or $650.
Principles of Nuclear Fuel and Power Management, Edward A. Mason, Professor of Nuclear Engineering, July 24-28, $400.
Principles and Methods of Nuclear Fuel and Power Management, Edward A. Mason, July 24-August 4, $750.

Nutrition and Food Science
Advances in Human Nutrition Knowledge, Vernon R. Young, Associate Professor of Physiological Chemistry (Department of Nutrition and Food Science), July 24-28, $350.
Fermentation Technology, Daniel E. C. Wang, Associate Professor of Biochemical Engineering, July 24-28, $350.
Advances in Dehydrated and Low-Moisture Foods, Marcus Karel, Professor of Food Engineering, and Samuel A. Goldblith, Professor of Food Science, July 31-August 4, $350.

Physics
Cooperative Phenomena and Phase Transitions: Principles and Applications, H. Eugene Stanley, Assistant Professor of Physics, June 12-16, $350.
Lasers and Optics for Applications, Shaoul Ezekiel, Assistant Professor of Aeronautics and Astronautics, July 10-21, $350.

Political Science
Forecasting Federal Budgets and Defense Expenditures, William W. Kaufmann, Professor of Political Science, August 14-18, $500.

Technical Writing
Communicating Technical Information, Robert R. Rathbone, Professor of Literature, August 21-25, $350.

Commons Goes Natural

Did you think commons food left something to be desired? Then try this menu: mung bean casserole, vegetable sukiyaki, carrot and soy bean loaf, lentil roast, or stuffed cabbage. Then add a side order of brown rice, organic peanut butter (what's inorganic peanut butter?), and crunchy granola. And for those snacks, try sunflower and sesame seeds, dried fruit, wheat germ, and brewers' yeast.

Those are a few of the specialties of the new "natural food" line at Walker Memorial. David Cantley, General Manager of Dining Services, says the goal "is to serve simply prepared meals that are high in nutritional value and natural flavor." Many of the ingredients—honey, beans, grains, seeds, wholewheat spaghetti and macaroni—are organically grown, but the term "natural" really means vegetables, fruits, fish, and poultry that are prepared simply, without additives.

Bland? Maybe. Fattening? Not necessarily; the menu also includes unbuttered fish, stewed chicken, fresh vegetables, salad, unprocessed natural apple juice, herb tea, and peppermint tea—all for those who do not want to be organically fattened.

Helen Doherty, Administrative Dietitian, began planning the new menus about three months before their introduction. After reading up on the subject, she chose several recipes and had Head Chef Joseph Principe prepare test batches for a panel of tasters. Then she adapted successful recipes for large-volume production.

The results? "We're very pleased," says Miss Doherty. Students on commons in other dormitories can transfer as many meals as they wish, and Miss Doherty finds she is "getting to know a crowd who come through quite regularly. They're very happy—and even offer new recipes." The line usually serves 100 to 160 per meal; this includes the "regulars" and, for every meal, a few curious "one-timers."

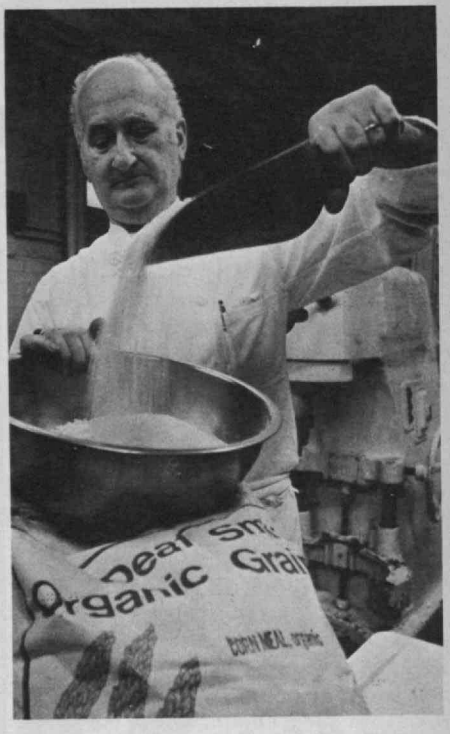
Telephones vs. Technology

There are no more pay telephones in Baker House, save two in the lobby. All the rest have been removed by New England Tel. and Tel. because of "vandalism and fraudulent use."

The telephone company is perennially a favorite target of student "hacks." Students describe it as "the world's most extensive multi-port network," and the electrically inclined among them delight in finding weaknesses which permit making long-distance calls at no cost.

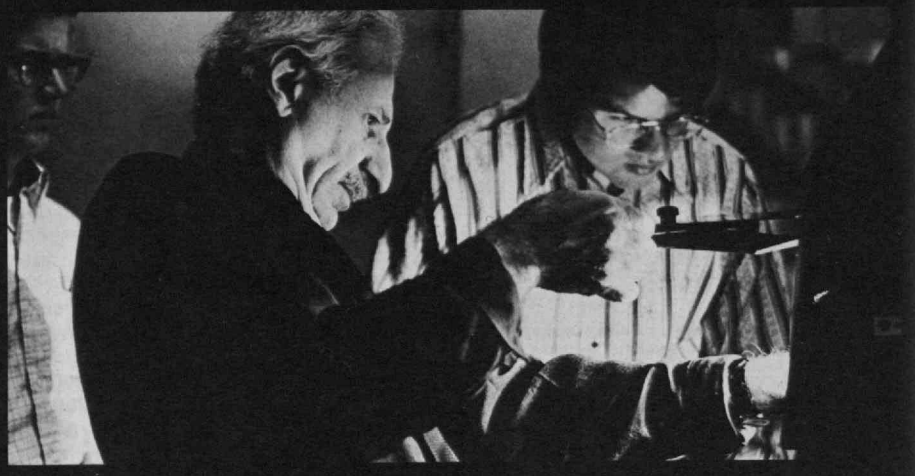
The company itself has been known to help—though inadvertently. One of the best-thumbed volumes in the Barker Engineering Library is the November, 1960, issue of the *Bell System Technical Journal,* which gives the combinations of tones used by operators and automatic equipment to switch and control long-distance trunk lines.

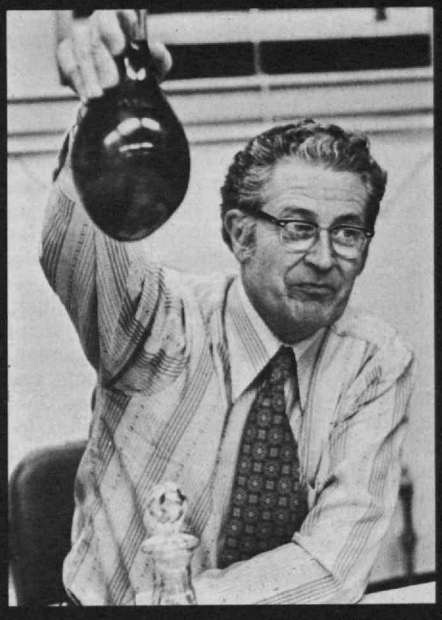
But pay telephones are the telephone company's *bête noire.* Two special weaknesses—aside from the mask of anonymity afforded the hacker—make them fa-

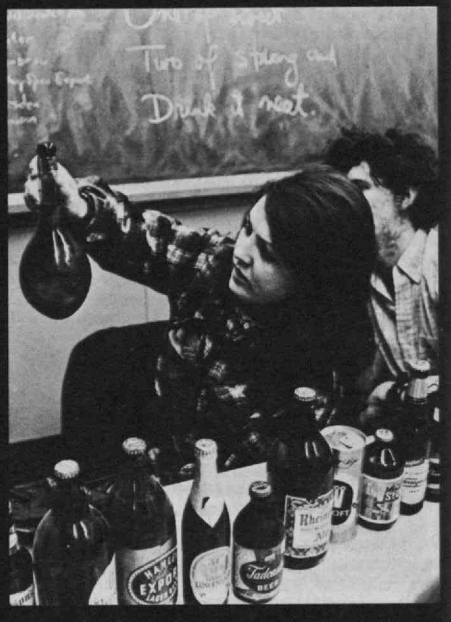


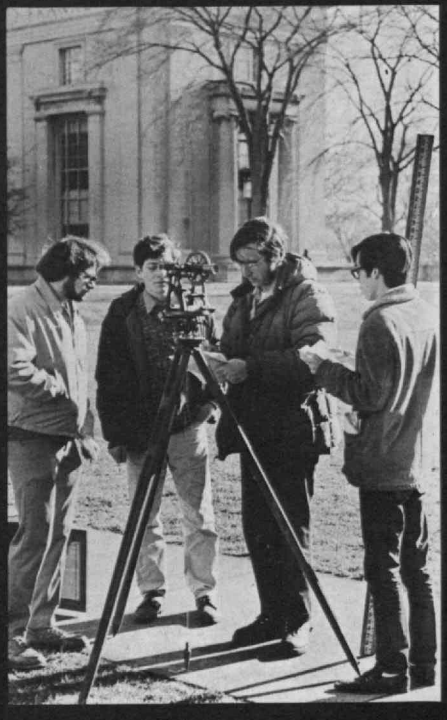
Soy bean loaf and lentil roast? Maybe it's not quite the way it sounds. Tasters Richard G. Collarini, '72, Mark J. Aquino, '72, and Cheryl A. Reilly, '73, prepare their verdict on the new (optional) commons fare (above), while Chef Joseph Principe of the Walker Memorial kitchen dips into the "organic" corn meal for one of his new "natural" dishes. (Photos: Boston Globe*)*

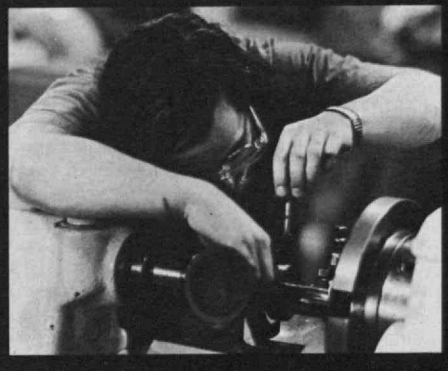
The Gallery

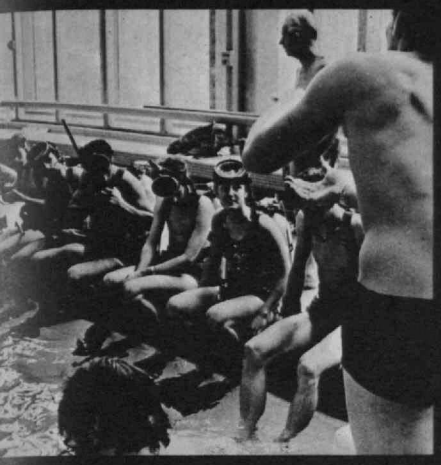












January was devoted at M.I.T. to Independent Activities Period—the "do-your-own-thing month." Some 70 per cent of the students used their dormitory rooms, and their activities included classes, seminars, and laboratories. Some subjects were routine, some (pictured here) more exotic: metal sculpture, surveying, machine tool operation, photography (with Gjon Mili, '27), wine tasting (with Sanborn C. Brown, Ph.D.'44), biophysics, modern dance, and scuba diving. (Photos: Margaret Foote and Sheldon Lowenthal, '74)

Libraries: Hard Choices Ahead for an Expensive Success

Since the 1950s, M.I.T.'s Libraries have been one of the Institute's success stories. The collection has grown from just over 700,000 to 1.3 million volumes in the past ten years, and the budget has grown in the same period from $600,000 to over $3 million.

But, asked Walter A. Rosenblith, Provost, at a recent faculty meeting, "Can we afford that kind of success?"

On the agenda was the report of an *ad hoc* Committee on the M.I.T. Library System chaired by Robert A. Alberty, Dean of the School of Science. Although complaints about M.I.T. library services are rare, Dean Alberty's Committee found the cost of library services is growing significantly faster than the overall M.I.T. budget—and it is doing so in a time when the Institute is searching for ways to reduce expenditures.

Indeed, the Committee concluded, if current policies are maintained without continued increases in the Library budget, then "deterioration of the whole Library system" will result. Instead, it proposed a closer relationship between supply and demand: "Identify in specific terms the support that the Libraries are expected to provide . . . and concentrate Library resources accordingly, in the hope that such support can indeed be provided with funds which remain a reasonably constant percentage of the total M.I.T. budget."

The Committee's central recommendations were that Library operations should be intimately linked with the departments and laboratories they serve (and possibly that their budgets should also be so linked), that the several libraries and reading rooms should be managed as a more consolidated system, and that M.I.T. should vigorously explore possibilities for cooperation with other libraries in the area to reduce each's burden of maintaining seldom-used materials.

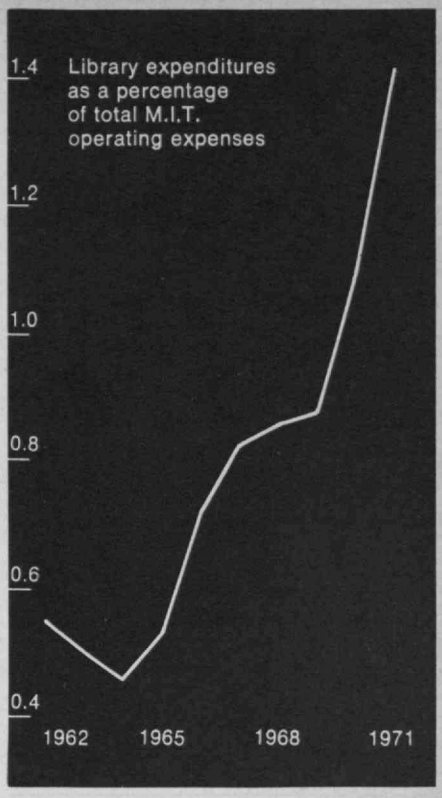
Other recommendations in the Committee report:

☐ Department heads, faculty, and students should have increased involvement in the allocation of Library resources.

☐ Computers offer the only way to maintain proper control over the huge volume of Library business. "It isn't so much that money can be saved by computerizing clerical operations, although this indeed may be the case, but rather that the information necessary . . . can no longer be obtained through manual operations."

☐ Undergraduate students should be better served by better management of reserve materials and by providing more general resources, such as popular nontechnical books and journals.

☐ "Better information on usage and need is required to guide the acquisition process. . . . The usual policy is to buy any book requested by a faculty member, even if it is available in another M.I.T. Library." (The collection has grown an average of 7 per cent a year in the last decade, and space as well as money is becoming a problem.) M.I.T. subscribes to some 17,000 different journals and serials, or an average of some 17 per faculty member. "We recommend that faculty committees rate current journals according to expected use and that alternate ways of obtaining the less frequently used journals be developed."



M.I.T.'s library expenses have been growing significantly faster than its total operating expenses. The result is that, in a time of belt-tightening, the libraries are asked to "accept the responsibility for limiting their growth."

In sum, says the report, the Libraries will have to "accept the responsibility for limiting their growth while at the same time meeting the needs of the community." The best range of services is not necessarily that which is now offered.

Professor Rosenblith added some advice of his own: "Very soon, departments might have to start choosing between an assistant professor and that eighteenth periodical per faculty member."

Industrial Relations Librarian

Miss Barbara Klingenhagen, whose bibliographies of industrial relations are nationally known as an outgrowth of her efforts to develop a distinguished special collection in that field within the Dewey Library, retired at the end of 1971.

Miss Klingenhagen came to M.I.T. in 1935 and became the Dewey Librarian when the Institute's collections in industrial relations were merged with those in economics and management in 1954.

In her tribute, Natalie N. Nicholson, Associate Director of Libraries, praised Miss Klingenhagen especially for her "example of excellence" and "for never forgetting the purpose of a library in the midst of procedural apparatus."

vorite targets. A pay telephone is a three-terminal device; a pulse applied across two of its terminals causes it to "swallow" the coins it has been fed. A pulse of the opposite polarity applied across the same terminals causes it to send the coins to the coin return instead. A simple trick, therefore, is to expose the wires leading into the telephone and insert a full-wave bridge rectifier; the phone will always return the coins it receives.

Alternatively, a small hole drilled in the face of the telephone gives the hacker access to the relay mechanism which those pulses operate. All that is needed then is an unfolded paper clip.

The telephone company assigned a full-time crew to spend last summer at M.I.T. putting all the pay telephones on campus in perfect working condition—and that means working the way the telephone company intends them to work.

But when the fall and students came, the hacking resumed—in full force only in Baker House, curiously. As Paul Schindler wrote in *The Tech*, "Phones were drilled, holes were filled, tones were trilled, and N.E.T.&T. was bilked. They balked."

Science, Library, and Visual Arts Grants

Six grants totalling nearly $800,000 were reported at M.I.T. during the winter:

☐ $86,451 from the John A. Hartford Foundation of New York City to support studies on the control of certain brain activities—for example, sleep—through diet-induced alterations in blood chemistry. The funds will be used by Dr. Richard J. Wurtman, Professor of Endocrinology and Metabolism, and colleagues in the Department of Nutrition and Food Science.

☐ $121,394 from the National Science Foundation under a program of institutional grants to help maintain teaching and research programs in the sciences fundamental to advanced work in engineering, mathematics, and science.

☐ $100,000 (two annual $50,000 grants) from the Samuel H. Kress Foundation to support activities of the Center for Advanced Visual Studies under the direction of Gyorgy Kepes, Professor of Visual Design. Professor Kepes describes the Center's work as "an exploration of new artistic objectives of civic scale and environmental dimensions, . . . a needed confluence between scientific and technological knowledge and artistic creativity."

☐ $50,000 from the National Endowment for the Arts, to match the first of the two Kress Foundation grants (*see above*).

☐ $38,911 from the National Science Foundation to make possible a summer institute, to be conducted in M.I.T.'s Education Research Center, for high school teachers who want to improve the effectiveness of their instruction in science and mathematics.

☐ $400,000 from the Council on Library Resources to extend for one year the computer-based experiments in information storage and retrieval of Project INTREX, whose technical library techniques could be the prototype for future reference collections. Work includes development and testing of a machine-oriented library system now in use at the Barker Engineering Library at M.I.T.

A. D. Little Professorship

A five-year grant from the Arthur D. Little Foundation will make possible an interdepartmental faculty chair, the Arthur D. Little Professorship in Environmental Science and Engineering, at M.I.T.

The purpose is to recognize and support a younger member of the faculty engaged in research and teaching in environment-related areas of science and engineering. Jerome B. Wiesner, President of M.I.T., said in announcing the grant that he hopes it can be used to make possible interdisciplinary work in such fields as the technology and legal aspects of environmental control or the physiological impact of environmental chemicals. The new Professorship, he said, "will be an important contribution toward expanding the ways in which M.I.T.'s special talents and skills can be applied to the improvement of environmental quality."

Thomas R. Olejarski, 1954-1972

A timeless—if pointless—college tradition ended in tragedy at M.I.T. on January 11: early that morning Thomas R. Olejarski, '75, fell to his death from a fourth-floor balcony at the Tau Epsilon Phi house during a water-balloon fight.

According to witnesses, Mr. Olejarski was leaning over a stairwell railing preparing to drop a water-balloon when he slipped on the wet floor and fell; he was alone on the fourth floor. Fraternity brothers gave first aid and summoned help at once, but Mr. Olejarski was pronounced dead on arrival at the Massachusetts General Hospital.

Mr. Olejarski was 18 years old and came from Rochester, N.Y.

After a careful investigation, Associate Dean for Student Affairs Richard Sorenson could only suggest that students "lessen this kind of activity. . . ." Despite the dangers and a fair number of injuries, water fights and "shower parties" have for years been a leavening aspect of life in the undergraduate residences.

Associate Electrical Engineering Head

Mildred S. Dresselhaus, an authority on solid state physics who has been Professor of Electrical Engineering since 1967, has been named Associate Head of the Department of Electrical Engineering for Electrical Science and Engineering. She succeeds Wilbur B. Davenport, Sc.D.'50, who becomes Director of the Center for Advanced Engineering Study.

Announcing the appointment, Louis D. Smullin, S.M.'39, Head of the Department, noted that M.I.T. activities in electrical engineering are "widespread both intellectually and geographically." The need for "effective communications mechanisms" is therefore great, he said; hence the designation of two Associate Heads for the Department. (Robert M. Fano, Ford Professor of Engineering, is Associate Head for Computer Science and Engineering.)

Dr. Dresselhaus becomes the first woman appointed to a major academic post in a department of the M.I.T. School of Engineering. For six years before joining the faculty Dr. Dresselhaus was a member of the staff at the Lincoln Laboratory, where she made important contributions to research in the energy band structure of solids and the electronic and magneto-optic properties of solids. Dr. Dresselhaus studied at Hunter and Radcliffe Colleges and holds the Ph.D. (1958) from the University of Chicago. Her husband is a well known theoretical physicist who continues as a staff member at Lincoln Laboratory.

Aviation Expert to M.I.T.

John R. Wiley, '33, who retired on February 1 as Director of Aviation for the Port of New York Authority, will become Visiting Professor of Aeronautics and Astronautics at M.I.T. on July 1, where he will participate in teaching and research in the Flight Transportation Laboratory.

Mr. Wiley is widely known as an expert in airport management, and he has been a leader in developing new concepts and standards of airport planning and operation. In his present post for more then 15 years, he has directed the development of Kennedy, LaGuardia, and Newark Airports to serve over 40 million air passengers a year; during his administration of these airports, the Authority has invested almost $1 billion in their development as a regional air terminal system.

Mr. Wiley joined the Port Authority in 1950 as Deputy Director of Aviation, having for six years previously been Assistant to the President and Director of Planning and Controls at American Airlines; he served in the Air Transport Command during World War II. Before taking up his new duties at M.I.T., Mr. Wiley is now associated with the Civil Aviation Safety Centre in Beirut, Lebanon, where he is preparing and teaching a course on airport operations for government and airline personnel from developing nations.

Lincoln Appointments

Walter E. Morrow, '49, and Daniel E. Dustin, S.M.'49, have been named Associate and Assistant Director of Lincoln Laboratory, respectively. Both have long records of service in engineering and administrative assignments, and in their new posts both will give direct support to Gerald P. Dineen, Director of the Laboratory, in his management and development responsibilities.

Mr. Morrow joined Lincoln Laboratory upon its formation in 1951, following undergraduate and graduate study at M.I.T.; since then he has been active in Lincoln work on a wide variety of radio communications techniques and systems problems. Mr. Dustin joined Lincoln in 1953 and has helped shape the Laboratory's programs in ballistic missile defense technology.

R. B. MacMullin

W. S. Robson

J. K. Dillard

F. Y. K. Sunn

L. R. Morris

A. D. Moll

Individuals Noteworthy

To **Robert B. MacMullin,** '19, the Perkin Medal for 1972, American Section of the Society of Chemical Industry . . . to **Richard J. Reed,** Sc.D.'49, the A.M.S. Second Half Century Award . . . to **Gary A. Plourde,** '59, the A.I.A.A. Goddard Award . . . to **Leo A. Paquette,** Ph.D.'59, the 1971 Morley Award, Cleveland Section, American Chemical Society . . . to **Pietro Belluschi,** former Dean of M.I.T.'s School of Architecture and Planning, the 1972 Gold Medal of the American Institute of Architects . . . **Karl A. Gardner,** '34, to Fellow of A.S.M.E.

Dean A. Horn, N.E.'49, to Special Commission to Study Marine Boundaries and Resources of the Commonwealth of Massachusetts . . . **Wylie S. Robson,** S.M.'56, to Member National Export Expansion Council . . . **Joseph K. Dillard,** S.M.'50, to Vice President of I.E.E.E. **Philip M. Morse,** Professor Emeritus of Physics at M.I.T., to President, American Physical Society . . . **George W. Cherry,** former Deputy Associate Director of Draper Laboratory, to Deputy Associate Administrator for Programs in Office of Advanced Research and Technology, N.A.S.A. . . . **George B. Field,** '51, to Professor of Astronomy, Harvard University . . . **Robert C. Murphy,** Ph.D.'70, to Assistant Professor of Pharmacology, University of Colorado School of Medicine . . . **S. William Gouse,** '53, to Director of Environmental Studies Institute, Carnegie-Mellon University.

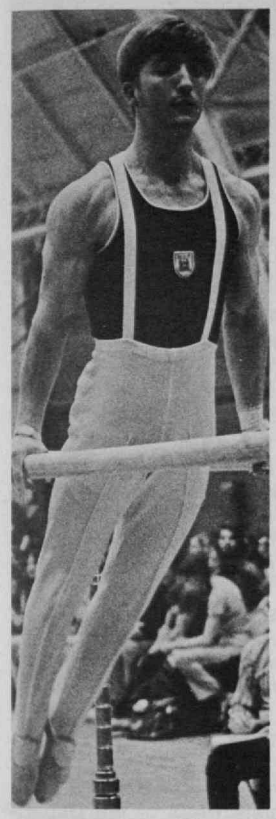
M.I.T. Appointments: **E-an Zen,** to Crosby Visiting Professor of Geology, Department of Earth and Planetary Sciences . . . **Charles H. Stevens,** Associate Director for Library Development at Project Intrex, to Executive Director of the National Commission on Libraries and Information Science . . . **Leslie M. Boring, Jr.,** '64, to Special Assistant to the Vice President and to Head of the Department of Chemical Engineering . . . **Jerome J. Schaufeld,** Industrial Liaison Officer, to Director of M.I.T. Associates; and **Dennis J. Jedlinsky,** '66, and **Anne S. Hirsch,** '69, to Industrial Liaison Officers . . . **Barrett O'Neill,** '48, to Visiting Professor in Department of Mathematics. . . . **Paul O. Roberts,** S.M.'57, to Professor, M.I.T. Department of Civil Engineering.

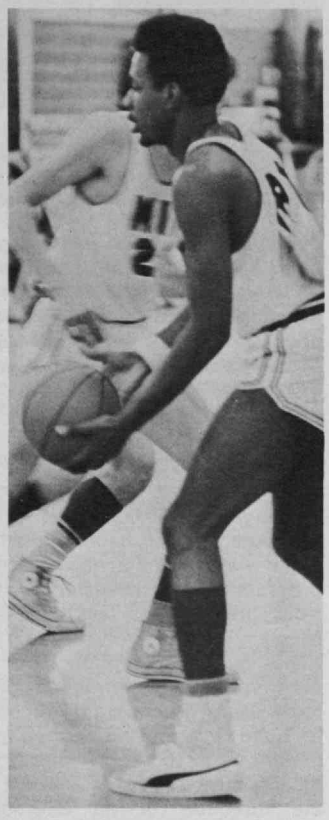
Allen C. Potter, '53, to Director of Research, Torin Corporation . . . **Franklin Y. K. Sunn,** S.M.'52, to President and Chief Executive Officer, Metcalf and Eddy, Inc. . . . **C. J. Lawson,** '43, to President and Chief Executive Officer, Rotron Inc. . . . **A. Lindsay Thomson,** '39, to Chairman and Chief Executive Officer, Terry Corp. . . . **Lee R. Morris,** S.M.'54, to Vice President, Insurance Company of North America . . . **Leonard I. Hess,** '61, to Executive Vice President, Butler Capital Corp. . . . **A. Donald Moll,** '43, to President, Minneapolis Electric Steel Castings Co. . . . **Donald F. Heaney,** '53, to General Manager, Water and Waste Treatment Department, Dravo Corp. . . . **Stephen D. Moxley,** S.M.'50 to Vice President, Avco Electronics . . . **Robert F. Lathlaen,** S.M.'46, to President, W. J. Barney Corp. . . . **Robert H. Welsh,** '48, to Senior Vice President, Ludlow Corp., Needham Heights . . . **Albert Q. Y. Tom,** Sc.D.'51, to President and Chief Executive Officer, Sunn, Low Tom and Hara.

Deceased

Eugenia Frothingham, '99, December 30, 1971
Frank E. Burnham, '00, September 10, 1963
Harold H. Davis, '02, December 6, 1971*
Fritz C. Bickford, '05, November 15, 1968*
Prince S. Crowell, '05, February 4, 1972*
Charles E. Abbott, '06, October 2, 1971
Richard C. Ashenden, '07, December 27, 1971*
Herbert W. Day, '07, November 13, 1971
Donald H. Maxwell, '08, November 28, 1971
Charlton D. Putnam, '08, December 6, 1971*
E. Russell Willson, '08, February 6, 1972
Charles W. Radford, '09, December 12, 1971
Elmo A. Robinson, '09, January 17, 1972
Eugene O. Christiansen, '10, December 18, 1971
Edward S. Howe, '10, December 18, 1971
George A. Taylor, '12, October 24, 1971
Paul V. Faragher, '13, January 20, 1972
Herbert I. Knowles, '15, January 2, 1972
Edward H. Clarkson, Jr., '16, January 15, 1972
Venaldo H. Harshbarger, '16, July 2, 1968
Edward B. Peters, '16, February 3, 1972
Herbert H. Porter, '16, July 1969
Lucius T. Hill, '17, January 4, 1972
Daniel C. Hall, '19, December 28, 1971*
William Pinkney, Jr., '19, February 27, 1970
Frank P. Reynolds, '19, January 29, 1972
Louis Wolff, '19, January 28, 1972
Senichi Fujimura, '20, August 21, 1970
Edward S. C. Smith, '20, November 11, 1971
Winslow Wetherbee, '20, August 7, 1971
John J. Collins, '21, February 9, 1972
Henry P. Harris, '21, September 18, 1971
Herbert W. Reinhard, '21, February 6, 1972
Charles R. Bailey, '23, January 27, 1972
Thomas H. Boyd, '23, February 12, 1972
Hugh A. Corr, '23, May 16, 1962
Gordon S. Crispin, '23, April 22, 1971
Alberto Lobo-Guerrero, '23, May 2, 1971*
Philip M. Stearns, '23, December 12, 1971
James C. Walton, '23, February 3, 1972
Stephen Webber, '23, July 13, 1971
Karl E. Luger, '24, July 28, 1968
Richard H. Walker, '24, February 3, 1972
Byron J. Connell, '25, January 30, 1972
E. Irvin Richardson, '25, July 24, 1971
Ervin W. Berry, '26, May 17, 1971
David R. Campbell, '26, January 29, 1972
Carleton J. Everett, '26, June 20, 1971
Lucien R. St. Onge, '26, February 15, 1971
Samuel W. J. Welch, '26, May 29, 1971
Charles V. Bullen, '27, February 27, 1971
Clarence E. Gregory, '28, June 8, 1971
Gerard V. Patrick, '28, December 20, 1971*
Carlton C. Champion, Jr., '29, October 20, 1971
Thomas M. Emery, '30, November 25, 1971
Tufic-Antonio Chemor, '31, January 15, 1972
Irving W. Finberg, '31, October 30, 1971
William C. Mentzer, Jr., '31, December 23, 1971
T. Stewart Varey, '32, October 16, 1971
John D. Howell, '33, July 1970
Hermann Laudani, '35, January 15, 1972
Russell W. Bandomer, '36, October 29, 1971
Sherman K. Shull, '36, February 1, 1972
Harry N. Tichnor, '36, June 16, 1969
Giles G. Green, '38, July 12, 1971
Alphege A. Landreville, '38, January 25, 1972
August Schomburg, '38, January 14, 1972
John F. Aldridge, Jr., '39, May 23, 1971
Theodore P. Snow, '39, December 15, 1971
James H. Campbell, '40, January 24, 1972
Richard H. Gould, Jr., '41, January 3, 1972
Francis E. Swain, '47, October 1, 1971
Charles A. Gibbons, '48, December 11, 1971
John C. Ornea, '50, December 21, 1971
Roy R. Benjamin, Jr., '51, January 8, 1972
David H. Weaner, '57, August 1969
Richard F. Childs, '59, October 29, 1971
Joseph D. Becker, '66, October 10, 1971

* Further information in Class Review





There were stars galore in the winter sports season; four of them are shown above: the Black Student Union intramural basketball team won the M.I.T. championship; John Good, '72, won All-American honors in pistol; Lawrence D. Bell, '74, was a double winner in the New England Gymnastics Championships; Harold Brown, '72, became the highest-scoring basketball player in M.I.T. history; and Theta Chi took the intramural hockey championship for the second straight year. (Photos: David M. Tenenbaum, '74, Bradley C. Billetdeaux, '72, and Margaret Foote)

Mixed Reviews

Before you signed up for the second term this winter, you could read what many of your colleagues thought of the courses you might study and the teachers you might choose. A 16-page tabloid-size "Course Evaluation Guide," developed as a cooperative venture of the Class of 1972 and the Technology Community Association, contained ratings, warnings, and advice—by far the most elaborate review of its kind seen recently on the M.I.T. campus.

The "Guide" was a compilation of judgments on questionnaires which asked students to rate their fall-term courses on a scale from 5 (high) to 1 in terms of such qualities as pace, depth, correctness of the catalog description, application to other courses, structure, and unity; and teachers on a similar 5-to-1 scale on knowledge, communication, responsiveness, and teaching.

Perfect scores were hard to come by; indeed, Robert B. Newman, M.Arch.'49, Associate Professor of Architecture, had the only 5.0 rating among the entire faculty for his performance in 4.43: Environmental Control—Acoustics. "A sure-fire winner," said the editors. Other high ratings went to Emmett A. Witmer, Sc.D. '51, Professor of Aeronautics and Astronautics, in 16.20: Mechanics of Solids ("knows his material very, very well . . . Students came away awed with his ability"); Donald L. Kreider, Ph.D.'59, Visiting Professor of Mathematics, who drew 50 5.0's on the question, "How well does he prepare and know his material?" in 18.01: Calculus; and Huston C. Smith, Professor of Philosophy, whose 24.352: Philosophies and Religions of Asia, was called by one student "the best humanities course I've ever taken."

Some other comments of the compilers —who included Harvey Baker, David A. Himmelblau, and Sandra G. Wiener of the Class of 1972:

☐ Low grades for lecturing "were primarily due to his habit of projecting the class notes on the screen . . . rather than deriving them on the blackboard at the note-taking speed of the class."

☐ "Lab reports are considered a general pain. It takes real effort to put together an impressive, pompous, and detailed report which even includes recopying the instructions."

☐ Under 7.01: General Biology, "Luria is a more entertaining lecturer . . ."; but under 7.21: General Microbiology, ". . . it was virtually impossible to take notes during the lectures due to Luria's manner. . . ."

☐ ". . . whose habit it was to literally run from the classroom two seconds after he had said his last word of the lecture. He was usually first out the door and students found him generally unapproachable and cold."

☐ "The programmed instruction made (it) almost enjoyable."

☐ "A message to Professor Negele from your class: your course is really good and people find it educational, but please, please don't always stand directly in front of what you write on the blackboard."

Early in the planning stages, Mr. Baker

said he approached Provost Walter Rosenblith, "who tried to discourage us, but we didn't listen." Then, at Professor Rosenblith's suggestion, he asked the faculty's Committee on Educational Policy for permission to distribute questionnaires in the classrooms. "They refused politely," Mr. Baker said.

"We feel we were right in that," Professor Hartley Rogers, Jr., Chairman of the Faculty explained later. "It was better to make it a completely student effort."

New Director, Broadened Base for International Studies

Eugene B. Skolnikoff, '49, Head of the Department of Political Science, has been named Director of the Center for International Studies, and coincident with that appointment the Center itself—formerly a part of the School of Humanities and Social Science—has been made an Institute-wide interdepartmental research activity.

Professor Skolnikoff, who will continue as Head of the Department, succeeds Everett E. Hagen, Professor of Economics and Political Science, who has directed the Center since 1970 and who will retire at the end of the current academic year.

To assist Professor Skolnikoff in fulfilling the two assignments, Donald L. M. Blackmer, Associate Professor of Political Science, has been appointed to the new position of Executive Officer in the Department of Political Science.

In announcing the appointments and the change of status for the Center for International Studies, Walter A. Rosenblith, Provost of the Institute, said, "We increasingly recognize the need for multidisciplinary approaches to problems of a social or political nature. By adding to the Center's social science program, we hope to encourage the growth of this multidisciplinary approach as it applies to problems of an international character." Among these Professor Rosenblith listed arms control, world communication techniques, and economic growth and development in emerging nations.

Professor Skolnikoff becomes Director of an enterprise whose 1970-71 budget was just over $900,000, nearly two-thirds of it provided by foundations. Its work included studies in international communications, science and foreign affairs, foreign policy, and disarmament and arms control policy; 27 M.I.T. faculty from the School of Humanities—chiefly the Departments of Economics and Political Science—form the nucleus of the research staff, and there are 30 full- and part-time research associates and affiliates.

No newcomer to policy research, Professor Skolnikoff began his international career as a Rhodes Scholar in 1950, having the year before graduated from M.I.T. in electrical engineering. Following his studies in economics, politics and philosophy at Oxford, Dr. Skolnikoff returned to M.I.T. and later served as staff assistant to three White House science advisers before joining the faculty in the Department of Political Science, from which he received the Ph.D. in 1965.

Technology and industrialization have made the world-wide scale the smallest on which today's problems can be successfully tackled, said Buckminster Fuller opening a distinguished lecture series at M.I.T. this winter. Then he read "a little poem" he had written:
"Environment to me must be
Everything that isn't me.
Universe to me must be
All that's me and isn't me!"
President Jerome B. Wiesner (center) was among those at the after-lecture bull session. (Photo: David M. Tenenbaum, '74, from The Tech)

Technology Transfer

A five-year, $900,000 grant to M.I.T. from the Agency for International Development will support a new interdisciplinary program in the transfer of technology from developed to less developed countries.

The purposes broadly are to define the types of information interchange most useful in extending technology and to build a group of trained people experienced in the social diffusion of technical skills. The program will be under the direction of an interdepartmental steering committee reporting directly to the Provost; Jack P. Ruina, Professor of Electrical Engineering, is Chairman.

The program begins, according to Professor Ruina, by recognizing that technology as now used in advanced countries is likely to be inappropriate for developing countries and that much technical assistance as rendered in the past—the simple pairing of skill to apparent need—has not been adequate. Hence the program will emphasize the development of new curricula and research in the applications of technology to developing countries; workshops and conferences to bring together faculty, students, and practitioners in developing countries to develop models and case studies; the creation of new fellowships, student stipends, and library resource materials; and exchanges with developing countries for work on concrete problems in field situations. The public works aspects of technology will occupy much of the new program's schedule of research and study, Professor Ruina says.

E. B. Skolnikoff *W. B. Davenport*

C.A.E.S. Director

Wilbur B. Davenport, Jr., Sc.D.'50, who has been Associate Head of the Department of Electrical Engineering, has been named Director of the Center for Advanced Engineering Study and—in that capacity—Professor of Engineering.

He succeeds Harold S. Mickley, Sc.D. '46, Ford Professor of Chemical Engineering, who became the first Director of C.A.E.S. when it was founded in 1963 under a $5 million grant of the Alfred P. Sloan Foundation.

As new head of C.A.E.S., Professor Davenport has a two-part assignment, according to Alfred H. Keil, Dean of the School of Engineering:

☐ Continue to extend current activities and programs of the Center to help working professionals refresh and renew their education on a continuing basis.

☐ Seek ways for the Center to bring similar resources to professionals who want to apply technology to "such large areas of social concern as transportation, energy, communications, environmental control, and utilization of natural resources." Developments in the Center organized around these issues could have "important impact on programs offered by the School of Engineering," Dean Keil said.

Class Review

95

A pleasant holiday surprise was to receive the following letter from Dr. Ching Yung Hsu from New York City, "It might surprise you that a stranger writes this to you. However, I am Chinese and was a student of your son, Dr. Fuller, Jr., who is one of the most dedicated educators in this country that I have ever met. You must be proud to have such a wonderful son who has made such great contributions in many aspects, particularly in the field of education for his country. The Chinese tradition is to honor the parents for having a great son. Best wishes for the New Year."—**Andrew D. Fuller,** Secretary, 1284 Beacon St., Brookline, Mass. 02146

96

The dean of the class is now **Richard O. Elliott** of Thomaston, Maine, who celebrated his 99th birthday on February 6. The youngest of the group is **Walter Otis Pennell** who reached his 97th milestone in January. He lives in Exeter, N.H. Elliott has always lived in his native town and Pennell returned to his when he retired some 30 years ago. Does the Florida Chamber of Commerce gather this type of news item?—**Clare Driscoll,** Acting Secretary, 2032 Belmont Rd., N.W., Washington, D.C. 20009

98

George R. Harrison kindly replied as follows: "It was good to hear from you, and I am glad to respond with a few items for the Class of '98 Notes, if notes from an Honorary Member are acceptable. I joined the Class at its 50th in '48 and have greatly enjoyed the association, attending reunions up to the 65th. Now I am past the 50th of my class '19 at Stanford. I am still working at the Institute finishing a research program, even though I retired as dean in 1966, and completely in 1971. I go to the spectroscopy laboratory almost every day when I am not away on a trip and hope to keep this up as long as they will have me about. I still do quite a bit of travelling, having been to Australia in August at the invitation of their Academy of Science. I visited nine universities, and got as far west as Perth on the Indian Ocean. Then in September my wife and I spent six weeks visiting Turkey, Iran, Afghanistan, Kashmir and Nepal, bringing back many colored slides with which to bore our friends. We left India just as the Pakistani planes began to come over. We envy you your following of the sun, and I try to comfort myself by trying to get my orchids to bloom when the snow here is three feet deep. Warm regards to all classmates from a dedicated foster-brother."

Here is a message from the *St. Louis Post Dispatch* for **Bob Lacy** who is interested in flying saucers: "Flying saucers are too firmly established in folklore to be exorcised by anything so trivial as an exhaustive scientific report."

Southern travel took us to Palm Springs, Calif., where it was a great pleasure to call on the wife of your former classmate, Mrs. Arthur Goodrich, who lives alone at 297 Minnehaha in the same lovely mobile home. Hazel talked about Arthur, and about many friends who live near her. In the summer she goes to a higher elevation where it is cooler. She continues her interest in M.I.T.—Mrs. **Audrey Jones Jones,** Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

99

A letter from Professor **Frederick W. Grover** indicates he has moved from Schenectady, N.Y., to Harvard Gap Lodge, N.C., to escape the cold winters. He knew of the location from his sister. He is well but he has decided to give up travel much of which he did for many years.—**Norman E. Seavey,** Acting Secretary, 20 West Lucerne Circle Apt. 514, Orlando, Fla. 32801

02

I have to report the passing of **Harold H. Davis,** Course VI, on December 6, 1971. Davis was in the engineering department of the American Telephone and Telegraph Co. from the time of graduation until ill health caused him to retire in 1921. He was a native of Chelmsford and returned there to make it his home until the time of his death.

Some vital statistics may be of interest. Our living members number 17 and all but Lombard in Pasadena are located in the East—seven are in Massachusetts, two each in New York, Florida, and Connecticut, and one each in Washington, D.C., Vermont, and Pennsylvania, and California. The *Review* reaches but ten of our members, the others have no ties with the Class Notes.

It is hard to realize that this year marks the seventieth since our graduation but such is the case. I send greetings to all. —**Burton G. Philbrick,** Secretary, Greycroft Inn, 68 Dane St., Beverly, Mass. 01915

03

We received a captivating and welcome letter from our long neglected classmate, **Herbert M. Morley,** of Hollywood, Calif. He was very surprised to receive my letter, supposedly because of the distance between us though he is not the least considered of our devoted group. However, he has also passed another milestone—his 90th birthday last June. He is in pretty good health save a growing period of "less pep."

Herbert left M.I.T. in 1903 after graduation to teach physics at Tufts University for three years. He then lived in Florida for some time but was lured to California for a permanent retreat from New England snow and ice. He values his long use of the auto, especially at present. His long career also included teaching physics and electricity in the Polytechnical High School in Hollywood until his retirement at 65.

We were shocked to learn of the sudden death of our devoted **J. Howard Pew** on November 28, 1971. I had recently received an announcement of his retirement from the huge international Sun Oil Co. as Chairman of the Executive committee. Howard died at his home, "Knollbrook," on Mill Creek Rd., Ardmore, Pa., at the age of 89. His career began after joining his father's company at the age of 19. He played a major role in guiding it from a small Pennsylvania-based firm to one of the nation's top 50. He joined the firm shortly after the discovery of oil at Spindletop, Texas. The heavy asphaltic crude oil was different from the crude oil used at its Toledo refinery. Howard joined the workmen attacking the problem at Toledo. The small group of re-

searchers worked day and night—even slept on the board benches until they obtained the formula for producing lubricating oil from Texas crude oil for general use. Howard then moved from the Toledo refinery to become superintendent of the Marcus Hook Refinery. Meanwhile the oil industry boomed and his own company lubricants won international acceptance.

He had been president of the company only a few years when he and his brother, Joseph started the Sun Shipbuilding Co., with dry dock facilities at Chester, Pa.; thus he became a leading builder of tankers used in World War II. In 1931 he helped in laying the first long-distance gasoline pipeline. He then supported his nephew in the first large-scale commercial development of catalytic cracking to produce high-octane motor fuel.

We received word that our loyal **Paul Revere Parker** passed away on October 25, 1971. He was followed three days later by his loving, devoted wife, Elinore E. Parker. They are survived by their daughter, Mrs. C. Francis Loutrel, and three grandsons, Stephen Loutrel, '65, Assistant Professor of Mechanical Engineering at M.I.T., and Charles and James. . . . Another ever-enthusiastic classmate, **Jim Welsh,** passed on October 24, 1971. Before retiring to Alexandria, Va., his very interesting life-work involved the transition of electricity and steam to diesel railway locomotion in New York.—**John J. A. Nolan,** Secretary-Treasurer, 13 Linden Ave., Somerville, Mass., 02143

04

In this issue I am reporting more information on that European trip taken by our good friend **George Kaiser.** Many thanks for your Christmas card George. "Our trip to Europe included Italy, Greece, Turkey and Yugoslavia—very interesting were the Greek islands Samos, Rhodes and Crete. In the latter we visited Kerosos, the site of the ruins of King Minos' 3500-year-old palace. Istanbul was fascinating. We had a splendid view of the Bosphorus, with its many ships, from our balcony in the Istanbul-Hilton hotel. We also visited the ruins of Troy which consist mainly of parts of stone walls. Also many of the Greek ruins in Asia Minor. In Yugoslavia we followed the S-shaped coast with its rugged Dalmatian mountains extending to the water's edge, on a broad two-lane asphalt highway as far as Split. Here we found a remarkable rectangular wall enclosing a church and the ruins of the palace built by Emperor Diacletian in 295 A.D. He was born in Dalmatia. We travelled in our own car which enabled us to view many historical sites not available to the average tourist."

Among my treasured Christmas cards was a picture of George Davis and son taken in his living room. I am sorry I cannot send you all a copy. They both look exceptionally well.—**Eugene H. Russell,** Secretary, 82 Stevens Rd., Needham, Mass. 02192

05

I am sorry to have to report the death of Grace Allen, wife of **Roy H. Allen, 3rd** of Phoenix, Ariz. Both had been hospitalized due to an auto accident. Grace lingered for four days. At last notice Roy had returned to the medical facility at the Orangewood Apartments. This is all the data I have at the moment. Hal Richards, who lives in the same apartment building, has written me twice, for which I am thankful. I hope to get details later.

Prince Crowell died suddenly on February 4, 1972. I have a copy of the *Falmouth Enterprise,* which devotes two columns to his life and glowingly tells of his remarkably fine career. It is a severe shock after recently writing so fully about his yachtsmanship and his vigor.

I also have learned of the death of **Max C. Richardson.** I do not remember him, but the *Technique,* 1902 through 1906 enrolls him as a member of the student body, which means that he should be remembered by some of the Class. . . . **Fritz C. Bickford** of Flushing, N.Y., died on November 15, 1968. He was enrolled in the 1903 and 1904 *Technique.* Our 40th year book states that he was with the Stone-Webster Co., in Boston as an engineer.—**Fred W. Goldthwait,** Secretary, Box 231, Center Sandwich, N.H. 03227; **William G. Ball,** Assistant Secretary, 631 Fordham Place, Bradenton, Fla. 33505

06

Here it is the middle of January with the snow all gone, lawns getting green, and the temperature up to 60. Prediction for tomorrow is in the teens and that is New England weather—we like it! We did appreciate the many Christmas cards, especially the messages on many of them. Thanks a lot. **Jim Wick, Jr.,** allowed his eyes are "sensitive and changing." I guess that is true for most of us now; some of us have had specs for years. . . . **Bob Cushman** wrote, "I am living in the house (in Portland, Ore.) that I designed and had built over 50 years ago." Bob didn't take the course in architecture but in mechanical, so I'll bet that house will survive earthquakes and tornadoes. Bob says he keeps busy in church and civic groups "plus interesting hobbies. In 20 years I will be 107 years old." Would you call Bob an optimist?

On a card from **Fay Libbey** he said he had talked with **Henry Mears** shortly before, "also received a card from Bob Cushman today, so '06 is still on the ball." . . . Replying to my recent note, **Howard Barnes** said, "Yes, Plymouth did celebrate its 350th birthday, from the spring of 1970 to last Thanksgiving." He and Marguerite live where he says he could once throw a stone to hit Plymouth Rock.

In a long letter on his card, **Jack Norton** says he keeps busy, drives a few blocks every morning doing errands (in Tryon, N.C.), helps around the house, and Margaret takes good care of him. . . . We appreciate the card from Agnes (Mrs. Harold V.) Coes and would like to know who sent us an *unsigned* letter on a UNICEF card. He evidently lives in or near Boston as he said he didn't know when he could get out to see us again. Thanks for the nice card anyway.

In the notes for the November '71 *Review* I referred to the nine class widows who are listed with the living members and said I suspected they contributed to the Alumni Fund. Then I commented at length about our '06 Memorial Fund, and gave some figures. In his letter to me about that fund, Ken Brock, its director, wonders "if there would be a way for the class to accelerate the growth of the Fund to its objective of $50,000. Do you suppose, for example, that some of the widows of deceased classmates would make a gift to that Fund in memory of their husband?" I would suggest that with every contribution to the Alumni Fund there should be a request that the

amount of the gift be *credited* to the '06 Memorial Fund. Half of its annual income, you know, goes for scholarship aid.—**Edward B. Rowe,** Secretary-Treasurer, 11 Cushing Rd., Wellesley Hills, Mass. 02181

07

We have a letter from **Milton MacGregor** this month. "My love of mountain climbing will probably be continued because in August I climbed Mt. Washington with my daughter, two granddaughters, and my son-in-law. We went up the Crawford Path and (by the way) were on the new Presidential Mt. Eisenhower (the renamed Mt. Pleasant). It was a very windy day; when we arrived on top we stood in snow which had fallen earlier that week. Later that week I climbed Rattlesnake mountain in Center Sandwich, N.H., with some of my family. This was the first time I had taken a great-grandchild up a mountain. The day of the climb up Mt. Washington was 17 days before I was 87."

We are sad to report the death of **Richard C. Ashenden** who died December 27, 1971. The *Boston Globe* writes, "Richard C. Ashenden, 87, retired President of L. L. Rowe Co. and Boston Nickel Plating Co., died in a West Newton nursing home after a long illness. Mr. Ashenden was born in Allston and graduated from the Newton Public Schools and attended M.I.T. He was a member of the Engineers Club, the Downtown Club, the Braeburn Country Club in Newton, the Menauhant Yacht Club in East Falmouth, the Dalhousie Masonic Lodge of Newtonville and was an active member of Central Congregational Church. He leaves his wife of 64 years, Grace C.; a son, Richard C. of Winchester; a daughter, Mrs. Marjorie Adair of Tucson, Ariz., five grandchildren and six great-grandchildren."—**Kathy Sayre,** Class Notes Editor, Technology Review, M.I.T., Room E19-430, Cambridge, Mass. 02139

08

We are sorry to report the death of another classmate **Charlton D. Putnum** of 5296 Grantland Dr., Dayton, Ohio 45429 who passed away December 6, 1971. He graduated as a civil engineer and was the first director of the Dayton Metropolitan Housing Authority. . . . We also want to report the death of two other members of our class. **William H. Toppan,** of 1130 No. Westfeeld St., Oshkosh, Wis. 54901 on November 13, 1971, and **Abraham S. Cohen,** 101 Tremont St., Boston, Mass. 02108 on November 5, 1971.

We have received a letter from the daughter of **Wilfred E. Booth,** our class agent, saying that he fell at their summer home in Jackson, N.H., on July 25 and broke his hip. He was rushed to the Mass. General Hospital in Boston where he was confined for a month and is now at a convalesent home in Norwood, Mass. We hope that he was able to reach his home in Foxboro for Christmas.

We have only one change of address to report: William Roy Heilman, Westminster Village, Highway 31 South, Greenwood, Ind. 46142—**Joseph W. Wattles, 3rd,** Secretary, 26 Bullard Rd., Weston, Mass. 02193

10

Your secretary has the sad news of the passing of **Even S. Howe** and **Eugene O. Christiansen** on December 18, 1971.

Walt Spalding wrote recently and told of a letter from **Jack Babcock,** full of his cheerful spirit and warm friendship. "He is a great fellow and I must tell him, in reply to his question, that we do plan to be in New England next summer, unless something unforeseen comes up. We are in good health and with income taxes out of the way and our local fight with Harry Bridges and his dock union practically settled by the forthright action of President Nixon, we may take a trip. It was a pleasure a week ago to hear from **George Lunt** and his charming bride, and to bring them up here, for a perfect afternoon on our lawn."

Carl Lovejoy writes the following: "A month after our 60th reunion, I was married to Mrs. Irwin Waite of Boynton Beach, Fla., the town where I have lived for 15 years. We returned to Boston for a week and then on to a cottage on a lake in northern Vermont for one month. We traveled all over New England then and saw Jack Babcock and Fred Lufkin a couple of times when we were at Casco Bay. We then made a few shake-down trips to the Everglades and Key West in our Volkswagen campmobile. This mode of travel has been a delightful experience. We met many interesting people who were retired and were seeing the U.S.A. from coast to coast. After visiting our relatives in Ohio, we went to many of the comparatively small flood control dams in the center of that state. There were 16 built in the 1930's and I was closely in touch with all of them when I was with the Army Corps of Engineers.

"Florida is a fine place for Senior Citizens but you must have friends to be happy there. Try a winter in Florida first. **Al Hague** stopped in before Christmas. They have sold their nice home and are living nearby in Pompano Beach in a very modern Baptist retirement complex."—**Herbert S. Cleverdon,** Secretary, 112 Shawmut Ave., Boston, Mass. 02118

11

A mild congestive heart attack in November put **O. W. Stewart** in the hospital for a while. He was back home before Christmas and is steadily improving. I talked with him on the phone in January and he told me he gets around the house all right and gets outdoors on warm days. He said his main trouble is lack of ambition in that he doesn't feel like doing anything. Last summer I called on the Stewarts at their home in Kingston where we walked out through his blueberry patch. He has acres of them including several varieties that ripen between late July and early October. I ate a pint right off the bushes and took a quart home with me. Besides his blueberries he has a large vegetable garden and a number of fruit trees that he says require many sprayings.

After six months hospitalization, **Paul Cushman** is back home but at Christmas time was not yet able to walk. You will remember, a broken hip kept him away from our reunion. It was the result of being hit by a truck last May. On the back of his Christmas card he wrote "Jim Duffy lived at 8 Mather St., Dorchester. He and I played scrub baseball a great deal all through the spring and summer before we entered Mechanic Arts High School." In those days Paul lived with his mother at 45 Mather St.

Harry Tisdale is the most faithful correspondent that I have among classmates. He sends me three or four letters a year from his home in Fort Meyers Beach, so his name gets into the Notes more frequently than anyone else. Like me, he is a widower living alone and is fortunate to have good neighbors. He was invited out to dinner Christmas and had an eggnog party at his house on New Year's eve that lasted till three in the morning. I could do very nicely with several more regular letter writers and will undertake to answer any letters that I get. . . . **Allston Cushing** is close behind Harry as a letter writer. A recent letter reminded me that he is a past National Secretary of American War Dads. He has one son who was a colonel in World War II and a second son who served in the Korean War. Allston spends two half-days a week doing voluntary service in the hospital.

Two messages have come to me by way of the Alumni Fund Office. From **Livingston Ferris** who attended our reunion last June: "Managing plantation—Retired from Bell Labs. in 1948." . . . From **Ormond Bean** of Portland, Ore., "We are having some hard luck: I retired from office at Portland City Commission as of December 31, 1966 after 24 years in that office (with state and federal offices mixed in). Mrs. Bean had a slight stroke July 18, 1971 and was getting over it when she broke her hip December 8, 1971 and is still in the hospital."

I received the following obituary of **Robert O. Wood** of Upper Montclair, N.J., "Robert Ordiorne Wood, Class of 1911, M.I.T., died suddenly July 1 1971. His home was in Montclair, N.J. Until his death he was connected with Republic Electronic Corp. in Paterson, N.J. He had three wishes: never to retire, never to leave the place he had grown to love and thirdly to see his grandchildren well on the road to growing up. He would have been 83 in August. He had many interests: engineering, composing music, writing, gardening, sketching and 'watching the world develop.' He leaves his wife, Elizabeth Angell Wood, a daughter, Mrs. Harlan A. Bartlett, a son, Samuel Angell Wood and seven grandchildren."

The deaths of two other men have been reported: **Frank Russell,** 139 E. 66th St., New York and **Charles Edwards,** 128 Prospect Ave., Douglaston, N.Y. While both spent some undergraduate time with us, neither graduated and I have no further information about them.

I have three address changes: Norman Duffett, 120 North Palmway, Apt. 5 Lake

Worth, Fla.; Ralph S. Pease, Essex Rest Home, South Main St., Essex, Conn.; and Frederick L. Woodlock, 3230 Lincoln Rd., 220, Indianapolis, Ind.—**Oberlin S. Clark,** Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

Albion Davis, our president and reunion chairman, is hoping to receive more registrations for our four-day sixtieth class reunion which will be held on the campus starting June 2. Within the past year there have been 42 classmates who have written me that they are expecting to be able to attend, plus 16 wives. Surely, we should be able to have at least 40 present. If there is a chance that you can be present, please notify Albion promptly, so that he may secure reservations from the Alumni Association as their guests at McCormick Hall on the campus. We want you with us. If you cannot come, won't you please write a note that can be read at the class dinner.

I received a Christmas letter from **Cy Springall** and Marjorie. She is now in relatively good health after repeated hospital visits the past year. Cy's arthritis continues to bother but does not interfere with his activities, which include daily rides in good weather. They are happily expecting the arrival of their second grandchild. . . . **Nelson Breed** of Wilton, Conn., writes that he spent the summer at Block Island and planned to visit England, Scotland and Ireland last fall. We are expecting to hear from him about his trip. He writes, "No special news, just enjoying life" . . . **Paul Tyler** advises from Holmes Beach, Fla., that he and Katherine plan another Caribbean cruise in February on the new Norwegian ship, *Southward*. They will visit two or three islands which are new to them. They are enjoying their Florida home and find even more concerts and other events nearby in Sarasota than was the case in Washington. They spend much time walking and swimming, both in the pool and in the gulf. Katherine has organized, and now supervises, a gift shop at the large Manatee Hospital with a staff of some 30 volunteer workers. . . . **Walter Triplett** wrote Paul a Christmas letter from his home in Mexico. He has apparently recovered from his hospital stay of a year ago. Last summer he enjoyed his usual annual visit to relatives in Michigan. . . . **Jay Pratt** and Priscilla are feeling much better, and this year again spent the winter at their favorite Acapulco, Mexico, where they reported warm and sunny weather.

It is my sad duty to report that **Arch Eicher** passed away suddenly of a heart attack in Cleveland on February 24. Arch had been fighting this trouble for three years and a year ago had recovered sufficiently to take a winter vacation in Florida where we visited with him at Jack Lenaerts' party. Arch was a prominent athlete while in Tech and led our football team to victory. A loyal alumnus, he attended all our reunions, and made regular contributions to our class news column. He was a wonderful chap and loved by all who knew him. He is survived by a lovely wife, Agnes, a married daughter, Alice, and three grandchildren.

Dave Guy writes from Washington, D.C., quoting from a book he had received for Christmas, "The pleasantest things in the world are pleasant thoughts, and the great art of life is to have as many of them as possible." Michel de Montaigne. Dave does a great deal of reading, mostly philosophy and a bit of astronomy in which he has long been interested. The past year his legs have given him trouble, forcing him to curtail the long walks in the country which he enjoyed so much. He says, "Family-wise, we have a son, a daughter and three grandchildren, all of whom live here in Washington. I am looking forward to the reunion and, health permitting, will surely be there." **Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

The winter of '72 is about half over; when you read these notes spring will be here. We have weathered the storms fairly well. We hope that some of our classmates were able to participate in the 24th M.I.T. Fiesta in Mexico, March 16-18. . . . The latest report on the 1971 M.I.T. Alumni Fund shows the Class of '13 leading the pack from 1900 to 1928 with a total contribution of $56,357. How about that?

It has been a pleasure to hear from **Henry** (Heine) **Glidden** who writes: "Am busy as usual painting. Have been in three shows so far this season and right now have two large watercolors on display at Brockton West shopping center in Cinema III and IV. More shows coming. Have also had several commissioned paintings to do. Keeps one out of mischief. As to reunion on campus, it makes it possible to see more men of other classes that one knew but of course, for a fun time you can't beat the Cape. These days I don't predict very far ahead, but we'll be there wherever it is if at all possible."

The holiday messages from several of our classmates and families was very gratifying; our sincere thanks to all. . . . **Ken Blake** remarks that we must get snow in Biddeford and compares it to the 40 feet of snow in a picture he sent taken near Mt. Rainier.

Phil Burt writes: "I hope you are enjoying your new home. Keep well." Maurine and **Allen Brewer** also send their best. This welcome letter from **John Welch:** "We go to Centerville on the Cape in the summer. Thanksgiving is a family meeting time for us at our daughter's home with their five children, and another daughter with their three children from Cincinnati. Am enjoying retirement. In March and April we go to Pompano, Fla., where we have been going to the same place for 14 years and know the group that goes there."

A wonderful friendship which began around 1905 between your Class Secretary and **R. Charles Thompson,** 1913 Class President, ended on December 12, 1971, when Charles passed away after a short illness. He was born in New Haven, Conn., lived in Winchester, Mass., and graduated from Winchester High School before entering M.I.T. He majored in chemical engineering. Charles was a member of the Theta Delta Chi fraternity, and a member of the '13 relay team, baseball and basketball teams. He won a varsity "T" and also ran on the outstanding one-mile relay track team. He was the representative on the Athletic Council Institute Committee and a member of Class Day Committee. Following graduation, he was employed by several concerns in Brockton, Mass., and about 1918 became associated with his father in the wholesale plumbing supply company of Thompson and Durkee, and succeeded his father as president until his retirement. He served with distinction as the 1913 Class Representative on the Alumni Advisory Council, Class Vice President, and for many years President of all Class Reunion Committees. After graduation he was very active as an advisor for his fraternity. He lived at 24 Westfield Rd., West Newton, Mass., and was an active member of the West Newton Unitarian Church. We of 1913 will all miss Charlie.

Teaneck, N.J.'s newest park named in honor of its former mayor, Clarence W. Brett, Class of 1913.

A resume of Harry Harrison's life and accomplishments has been received, and we quote: "**Henry C. Harrison,** inventor and pioneer in high fidelity phonograph recording, died on November 25, 1971, in Weybridge, Vt., at the age of 84. Mr. Harrison resided in Port Washington, N.Y., for 52 years. His work at Bell Telephone Laboratories resulted in more than 100 patents, and he was awarded the Elliott Cresson medal of the Franklin Institute in 1959, for his discovery and application of the principle of matched impedance in electrochemical systems."

It is always a privilege to report any honors that have been bestowed on our classmates. **Clarence Brett** writes of his trip East in October to be present at the dedication of Brett Park in his old home town, Teaneck, N.J., and sent a copy of the newspaper write-up of the dedication. Titled, "A Part of Teaneck Comes Home", the article tells of the dedication of the new park in honor of the 81-year-old former mayor. "Jim Brett—that's what his friends call him—doesn't get back to town much since he retired to Scottsdale, Ariz., in 1964. He's here for a week though, and for a good reason. Ten acres

of Hackensack river-front is about to be unveiled as Clarence W. Brett Park. It's a small favor from the town which Brett continues to refer to as home. 'I'd be lying if I didn't say this is still my home', he said. 'I have so many friends here, so many memories.' Brett spent 30 years in government in Teaneck, first as school board trustee in the 1930s, then 12 years on the Township Council. He was Mayor Brett from 1946 to 1950. The office gave him a seat on the planning board. He remained on the board until he left for Arizona. He hasn't exactly been inactive in retirement either. During almost 50 years in Teaneck he saw a lot of growing, and had a hand in some of it."

So until next issue, keep well and happy.—**George Philip Capen,** Secretary and Treasurer, **Rosalind R. Capen,** Assistant Secretary, Granite Point Road, Biddeford, Me. 04005

14

Herman Affel's many friends will be glad to hear from him; he wrote in February, "You were asking how I have been making out. I'd say not too bad—but not well enough to get to Cambridge on my own. As you know, I am affected by the so-called Ménière's syndrome, the characteristic symptom of which is dizziness. Medication keeps it under some control, but when I move about I carry a cane and do not go very far in case I need a helping hand. I get considerable satisfaction from acting for the Educational Council in interviewing prospective candidates for M.I.T."

All will join in extending sympathy to **Levi Bird Duff,** whose second son, William A. Shannon Duff, died on January 3, at the age of 51. Though he had spent much of the past two years in hospitals, his death was unexpected and sudden. Fama and **Walter Keith** came to the funeral service and stayed with Lee.

Notwithstanding his sad situation, Levi responded to my broadcast plea for news by writing, "As you know, I am still in harness with the County, mainly because the County Commissioners, under present rates of municipal salaries, have not been able to find anyone willing to take my job. The County (Allegheny, which includes Pittsburgh) has approximately 350 miles of arterial and collector roads under its responsibility, together with 134 bridges over the three major rivers, over small streams and valleys. Private practice as a structural engineer evaporated during the Depression, so I was invited to and accepted a 'temporary job' as chief engineer in 1936. In 1946 I was made director of the works department. However, I enjoy the work, and as long as I have my present good health and they want me, I intend to keep it."

Fred Karns wrote in December that he and Margaret were feeling fine and hoped to be with us in June. He added that he had been busy in civic, fraternal and social activities in his home town of Franklin, Pa.

Walter ("Johnny") **H. Leathers** was in Hartford on business in mid-January, and kindly stopped in to see your secretary. Johnny is still active as a manufacturers' representative in a territory that extends a 100 miles from his home in Hingham. He drives 500 miles a week and likes it. He has three married daughters and 11 grandchildren. In a letter a couple of weeks after his call, Johnny wrote, "The Vermont clan, numbering six, is headed by Davis Keniston, M.I.T. '49, and they ski, without interruption, from November to April. My wife, having undergone grave surgery in 1968, has so far recovered as to drive her sports car between home, the A and P, and the laundromat, and she gets away like a scared rabbit without being at all aware of it."

You'll recall from the January news that **Ray MacCart** took a dim view of driving to Florida, but in a January letter he reported his arrival at Pompano Beach after a fast trip on the new Auto Train, and went on, "Left D.C. at 8 p.m., January 12, arrived Sanford, Fla. at 11 a.m., January 13, and then drove to Pompano. Had a bedroom on the train. The last time I slept on a train was in 1941 when I was younger and didn't mind being shaken up. However, it beats driving for three or more days, so I intend to go back the same way." . . . **Jim Reber** wrote that he and Aminda had sold their home in Houston and were moving in December to a new one at the address given below. Jim added that they were both well, and that by spending eight months in Houston and four in Auburn, N.Y., he can play golf two or three times a week all year long.

Alden Waite writes of his 79th birthday, "This has been a big day for me." His son called from Paraguay, to wish him a happy birthday as well as his daughter from Alexandria, Va. He adds "All very pleasant and heartwarming. A good day in which to move into one's 80th year. I realize more and more how fortunate I have been in my family, friends, my schools and the associations that go with them, the various occupations and travels, and now to cap all this my painting and museum interests—an entirely new and rewarding life in old age. I try to put in three or four hours every day, generally in the field. It isn't safe to mention health except in a whisper, for fear the gods may be angered and chastise me for being uppity. I hope that we have a 1972 reunion and I can attend."

Philip L. Scannell died on January 13, 1972, in Lowell, his life-time home. He was with us in the last three of our undergraduate years, and received his degree in Course II. Phil was a registered professional engineer and was treasurer of the Scannell Boiler Works and of the Lowell Iron and Steel Co. He was a former president of St. Margaret's Boy Scouts and a former trustee of the Lowell Technological Institute. Phil was a member of the American Society of Mechanical Engineers, National Society of Professional Engineers, Lowell Chamber of Commerce and the Lowell Lodge of Elks. He was married to the former Mary Cooney, who survives him; as do four sons, two daughters, two sisters, a brother, and 33 grandchildren. Our sympathy goes to them all. In sending me a copy of the obituary, Johnny Leathers wrote that Phil's death ended 60 years of friendship, and he recalled Phil's irrepressible humor which furnished continuous entertainment.

New address: Harold J. Coleman, 3518 Roswell Rd., N.W. (B-1), Atlanta, Ga. 30305; Leicester F. Hamilton (office) M.I.T., Room 2-321B, Cambridge, Mass. 02139; Anning S. Hammond, 2155 El Camino Dr., Turlock, Calif. 95380; Raymond D. MacCart (winter), Harbor House, Apt. 506, 205 N. Riverside Dr., Pompano Beach, Fla. 33062; James B. Reber, 2110 Canongate Dr., Houston, Tex. 77027.—**Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, Ct. 06119

15

Early in December The Pirate had his turn—he was in a Boston hospital for three weeks for major surgery, requiring two big operations. It's been a slow, long recovery for George, but I know you'll all be glad that he is now ready to buckle on his sword and go out after them again. As **Ben Neal** wrote, "at our ages apparently we don't have the power of repair that we had at one time." . . . **Archie Morrison** had a pacemaker-job done early in the summer and aside from giving up his former great golf game, he has done all right. We all join in wishing these fine classmates all the best for long and continued good health.

The 52 Christmas cards we received from widely scattered classmates and their families were a warm reminder that the joy of Christmas is a good deal in living with the memory of fine old friendships. There were many pretty and unusual cards. On a colored print of Helen and **Ken Boynton,** Ken wrote they were going to Florida in early January, hoping for much less wind and much warmer water—and that's from North Carolina.

Joan and **Bur Swain** said they'd be sorry to miss our cruise sailing. . . . Marjorie and **Whit Brown** are enjoying Florida. At a dinner of the M.I.T. Club of South Florida, in December, Whit said there was only one man from a class before 1915. . . . **Alton Cook** signs himself "the old wolf"—a name, he alleges, he acquired from foraging amongst the widows. Ah me! When he was in Durham, N.C., he phoned **Lucius Bigelow,** who reports he is in good health and sends his best to Fifteeners. . . . **Ray Delano** wrote that it has meant a lot to him to attend the Class parties. Well, Ray, it's always nice to see you. . . . Helen and **Otto Hilbert** are spending the winter at Baja California, Mexico to watch the whale and elephant seals. . . . **Horatio Lamson** and his family, Sybil and Shirley, wished me all the best to "keep up the good old Class Supreme." . . . Helen and **Boots Malone's** card was a colored print of their pretty house in Chester, Vt., all covered with a winter's snow. They wrote, "It looks a little different in the summer." We know, we've seen it in all its beauty.

Virginia and **Hank Marion** are comfortable in Tucson. . . . **Ray Stringfield** wrote from L.A. that he had had a slow recovery from cataract and prostate operations but was able to enjoy two Christmas dinners. Then: "I had my 80th birthday and am gradually getting rid of

most of my chores. However, the attorneys still drag me in on tire-accident-cases and other rubber problems. I had to miss the reception out here for the new M.I.T. Chancellor." All the best Ray for good health and complete recovery. . . . **Jim Tobey:** "I doubt if I get to suffer in Florida this winter, but I might take a cruise if the Class funds could put up a suitable loan at 4 per cent interest." How about that guy? . . . **Harry Murphy**'s son, Peter and his wife sent a cute card with small pictures of Lucy and Harry's six grandchildren at all ages and stages.

Long distance cards came from Carmela and Gus Gross, '50, Guayaquil, Ecuador, and Margaret and Gilbert Mar, '51, Taipei, Taiwan. A card signed by the *Review* Editor and his staff made me feel that, after all, they do care. Grace and Harold Dodge, the hard working '16 Secretary sent an original hand-made card. . . . **Mary Plummer Rice** spent the holidays with a daughter in Vancouver, then thru the Canal for a few days in Caracas, a few more in Mexico City and avoided a month of cold, stormy New York—wonderful how she gets around. . . . **Alice Anderson** spent six weeks in the South Pacific to visit Australia, New Zealand and those colorful islands down under. . . . Then, there were cards from **Elizabeth Baker;** one hand-made from Ellen and Ellis Brewster '13; Tess Hilton; Virginia (Thomas) and Paul Johnston, '21; Vi Proctor, widow of Dix '17; Margaret Runels; Mary and Jim Scully (Frank's brother); May Sheils and her friendly family; Molly Swift; Edna and Frank Stubbings, '27; Barbara Thomas. Long may the flames of these fine old friendships burn brilliantly to light our lives into the future.

With that friendly spirit our classmates show in trying to do for one another, Whit Brown wrote to his old Course IV associate, **Bahjat Abdulnour** in Beirut, Lebanon, and received this impressive answer: "It was with pleasure that I read your letter of October 15, and have fully appreciated all its content. As you would have learnt by my letter to our Class Secretary, at the present time, conditions seem to be quiet and normal in the Middle East. The American peace initiative and intervention are bearing good fruit and I believe positive results will ensue. I am retired from all work, but am observing a new rise in building activities around the whole area. Financiers are making some big investments in the construction industry, and certainly it is giving them substantial profits. As we all approach the end of the road, past recollections always creep into our minds, and though difficult at its occurrence, we now say how sweet it was. My friend Brown, my sincere wishes and best salutations."

Frank Boynton, from L.A.: "I see **Bob Welles** occasionally when he is kind enough to give us a beautiful box of home-grown fruit from his lovely place in Altadena." . . . **Ted Brown,** Manchester, Conn.: "With my 80th birthday coming up, I am alive but not kicking very much. I agree with everything Phil Alger said about being 80 years old. Remember me to the Course X boys and others." . . . I wonder what happened to that funny man, **Stan Osborn,** who wrote from West Hartford: "I am out of the hospital now after a very lovely and intriguing convalescence."

On April 21, Friday noon, there will be a regular Class Luncheon at the M.I.T. Faculty Club, Cambridge. Then, on Alumni Day, June 5 we'll have our long established and popular class cocktail party followed by dinner at the Faculty Club. We hope to see many of you there. You all stay well and take care of yourselves.—**Azel W. Mack,** Secretary, 100 Memorial Dr., Cambridge, Mass. 02142

16

It's hard to believe but just two months from now we'll be off to Cape Cod for our 56th reunion to be held at the good old reunion spot, Chatham Bars Inn, where the tangy salt air and good companions will again be warmly invigorating. More details soon!

Paul Page Austin of San Francisco says that he and his wife went East last fall for the first time in many years. They had a short stay in the Waldorf-Astoria in New York followed by a conducted tour of New York state and across New England to see the brilliant leaves (a "complete success", he calls it) and several days in Boston. He writes, "The closest we got to M.I.T. was to drive by it in a taxi. . . . I enjoyed walking up and down Newbury Street where John Ingle and I lived, and on Commonwealth Avenue. What a change in these streets!"

Good deeds still make good news—news that travels near and far all over the good old U.S.A. How else can you account for a news item in a November St. Paul, Minn., newspaper about what **Harold Fuller** is doing as a hospital-volunteer in Salem, Mass? And how does all this reach our editorial desk? This all comes from Pearl (Mrs. Bob) Wilson in Washington. The headline reads, "Retired People Render Valuable Service as Hospital Volunteers." The article reports: "Harold Fuller, M.I.T. retired chemical engineer, now volunteers five days a week in Salem Hospital's accounting office and also visits long-term patients. 'In most instances, we try to use older men and women as volunteers,' explains a director of volunteers in St. Louis, 'since we feel that the lonely older person will relate more closely to someone in his or her own age bracket and that closer friendships can develop. In addition, it gives the older volunteer a very meaningful and important role to play at a time when life is at a slower pace and one wishes to keep occupied in something interesting.' "

From out in Sun City, Ariz., we have word from **George Waymouth** who says he and his wife stay put pretty much except for occasional visits to their two daughters, one in Berkeley, Calif., and one in Cincinnati, Ohio. George says that on one of his recent trips, he availed himself of "several opportunities to hobnob and discuss issues ('rapping' they call it) with members of the younger generation. There seems to be a certain aspect of disorientation, a certain running to and fro as though without a 'lode star.' Unfortunately this happens to be true among many of us oldsters, too. It seems to me the unfortunate shooting event at Kent State, inexcusable as it was, has brought them up short with the realization of the deadly serious results of taunting society beyond certain acceptable limits. They seem to have a greater necessity for instruction from the heart than from textbooks. I hope M.I.T. is aware of this."

At the end of December, **Francis Stern** wrote from his usual winter CoCo-Cabana address in Palm Springs and reported only fair weather (meaning, below average). He and Gladys got out for a daily walk, and he started to feel 100 per cent just two days after they arrived, and "it's amazing what this dry climate does for my lungs and breathing apparatus." . . . From Claire and **Arvin Page** in Winston-Salem we have word that they had a short visit from Mary and **Ed Parsons** who were en route to the fishing grounds off Newport, R.I. "We thoroughly enjoyed their short stay of two nights. They both appeared to be in excellent health, as is attested by the fact that they drove here from Memphis in one day, a distance of about 650 miles."

These 50th wedding anniversaries are brought to our attention. Isabel and **Earl Mellen** had their 50th anniversary on December 30th at the Governor Morris Inn in Morristown, N.J., with 15 of their 16 grandchildren in attendance. . . . **Allen Pettee** of Tryon, N.C., noted that he and Helen had their 50th in Summit, N.J., last June. He commented that the number at their 50th was 50 and asks, "What's the probability?" He should know that, in the words of Woods and Bailey, "it all depends on the assumptions!" . . . We judge the **Merrick Monroe**s don't mind bolstering the economy of the airlines again as Miriam plans to head for California in February to help take care of things as their second grandchild arrives. Merrick says he'll keep the home fires burning. We lap up a Kudo from **Clint Carpenter** who writes from Virginia Beach, "Your reminder regarding Class Notes is also a pleasant reminder of the wonderful time we enjoyed in June and your report in the current issue of the *Review* is really good. Upon leaving Chatham Bars Phyllis and I drove back across Connecticut to Newburgh intending to continue from there to Virginia Beach but decided to extend our trip somewhat over to the New York finger-lake region which I had not visited for many years. We thoroughly enjoyed it. Phyllis has just returned from another trip visiting friends and relatives so now we will both stay home until after Christmas, at least. Certainly miss Harold and Grace Dodge at the reunions and am always glad to hear the good reports."

Down Houston way **Kem Dean** writes of his growing family, "Thanks for your notes of October 20, and the photo of the group at the Cape. It was most kind and thoughtful of Ralph Fletcher to supply the picture. The main trip we have made was in early summer to Albany, Texas for the wedding of our oldest grandson. The young couple are living in Fremont, Calif., where he is associated with a cable TV company. Our next

grandson, my namesake, is at University of Texas, and the youngest Hargrove grandson is at Sewannee Military Academy. The oldest grandchild is a girl who is at University of Texas. Then the next one is a boy 19 who is at Washington and Lee in Lexington, Va., and the last is a girl of 12 who is in junior high school in Houston."

And **Tom McSweeney** follows the doctor's orders, "Here I go doing just what I am told (as usual). (1) What I've been doing. That's easy—as little as I can get away with, and according to my associates not enough. (2) Where have you been or are you going—as you may know our work takes me around quite a bit. I've been working in Oregon, Georgia and all over New England in the past year. My wife and I were in Ireland this summer not for business but pleasure—taking a course in school—learning something about my ancestors the Vikings, who were a tough bunch. (3) Who I've seen—very few 16'ers I'm sorry to say. (4) As far as children and grandchildren my son is a partner, and everyone else is fine. My oldest grandson went and got himself married—so far the rest are still single. (5) my recollection is that nobody gives a damn for my philosophy, and my personal philosophy is based on this fact, so I'll spare you."

Elizabeth Pattee writes from Meadowlakes, N.J., "All I have to offer is that I had a fine time at the 55th Reunion at Chatham in June and enjoyed it immensely and shall look forward to a repeat. My summer was spent as usual at my place on the shore of Maine, near Bath at Small Point, with the exception of the month of August when I attended some sketching classes at St. Andrews, New Brunswick, and tried to brush up on water-color sketching."

An echo relative to the item about **Harold Dodge**'s recent honor, included in January's notes comes from **Charlie Reed** who writes, "I have just come in from attending a banquet at the Walter Reed Army Center at which the Samuel S. Wilks Memorial Award was given to Harold Dodge. General Leslie Simon received the award for Harold and made some extremely complimentary remarks about Harold. Mil and I were honored to sit at the head table on this occasion and were tremendously proud of Harold's achievements in applying statistical control to quality. We spent three months in Maine this year and were reluctant to leave on the first of October."

In conclusion, your secretaries thank all our correspondents for supplying news of themselves and other classmates and urge you to keep it up. Write us a little or a lot according to the urge but write often to—**Harold Dodge,** 96 Briarcliff Rd., Mountain Lakes, N.J. 07046 or **Leonard Stone,** Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

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By the time you read this you will be quite aware of the fact that we are having our 55th Reunion this June. Already, here in February, it is evident that there will be a large attendance. For any of you who are still undecided, take the step now and send your word to **Tubby Strout.** You are assured of a thoroughly enjoyable time and the wives are a happy factor at all events. Whether you can take in Cambridge and the Cape or just one of them, do come.

Katherine and **Earl Lewis** had a very good trip to Mexico in January and "feel highly indebted to Conchita Lobdell Pearson for a never-to-be-forgotten evening." She escorted them around Mexico City showing them the historic and elegant Spanish San Andel Inn and the fabulous electrical displays, decorations and illuminations which adorn the city for miles. "Then Conchita took us to her home for a delightful dinner—a special event which we had never anticipated." Conchita is hoping to attend our reunion. . . . For another view of Mexico there is news of Helen and **Jack Wood** from San Diego. Returning early in January they had had a month "of cruising on our Discovery down the wild west coast of Baja California in Mexico. It was an incredibly beautiful experience."

Jack has been busy summer and winter with his sailing activities at the San Diego Yacht Club. His pupils have won several championships including the Snipe Nationals. The Sexy Sabot Sailers, his women's group, got so large he had to start a second class. Then the husbands, jealous, inaugurated Men's Evening Meets. In case you don't remember, Jack was Mr. Sailing at M.I.T. being Commodore of the Fleet. He also is Daddy of collegiate sailing. Making the break to San Diego a few years ago he continues to make real contributions to sailing—even if his Discovery is a motor cruiser.

Bill Eddy has retired from Metcalf and Eddy, Inc., but will continue his long association with that firm as consultant. He is a sailor too, so may have more time for his ketch. . . . **Ralph Ross** suffered a stroke just before Christmas but that did not stop him from officiating at the dedication of the Northern Vermont Regional Hospital at St. Johnsbury on January 30. Doris and **Bill Hunter** were at the ceremony and thoughtfully furnish details. Ralph, since retiring from the American Tel and Tel Co., which he joined in 1917 and returning to his native Vermont, has had many civic and state interests. His favorite was the local hospital which he took over some years ago as president of the board of trustees. His long and hard work consolidating it with another financially-ailing hospital was crowned by this dedication of a fine, modern, 100 bed, $6 million institution. (Since the writing of this news, Ralph suffered a second stroke and died on February 28. Bill and Doris Hunter attended the services in St. Johnsbury. We extend our sincerest sympathy to Dorothy and the family.)

Energetic and on the job **Howard Melvin,** our West Coast vice president, isn't going to be able to get to the 55th but he has done his bit to promote it to our 27 classmates on the coast. He has personally written to each one. Howard and Lu are enjoying their new home in the active adult community of Ashmont located in Jack London's "Valley of the Moon" near Santa Rosa, 50 miles north of San Francisco. He assures a hearty welcome to any who are traveling that way.

Reunion Chairman, **Henry E. Strout,** 48 Parker Rd., Osterville, Mass. 02655, will appreciate any questions, suggestions or change of plans you might have.—**Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

18

A few days ago I visited the offices of *The Tech.* There is a large room devoted to business departments, a second one for the news and editorial writers, and a third for production. I happen to be one of the few alumni subscribers, so I took this opportunity to look back at some of the issues of the 1917-18 *Tech* and compare them with those of today. There are differences. Our news notes concerned themselves with what was happening to us—such as the meetings of the Chemical Society, the Tech Show, and accomplishments of the faculty and alumni. Today the spectrum is much broader—involvement with faculty and administration on many subjects aside from curriculum such as responsibility of M.I.T. as a stockholder in many large corporations or policies concerned with social problems of poverty, war and pollution.

In addition *The Tech* comments on hiring and firing practices, tenure, quality of teaching, and grading pass-fail. There is much reporting of movies and music available in the Boston area. What is happening to the students is not emphasized. Whether all this is an improvement in *The Tech* is something for you to ponder.

The production schedule of *Technology Review* raises havoc with the calendar. At this late date, I would still like to thank those who sent Christmas greetings. . . . A note from **Elbert Bancker**—"I retired from General Electric 11 years ago and moved from Schenectady to Boynton Beach, Fla., two years ago and I married again two years later." . . . **Ed Little** writes, "Last fall I had seven days of hiking and climbing in the Smokies and Blue Ridge Mountains—marvelous scenery. I made several attempts to get in touch with Ned Longley while at Hendersonville, but had no luck."

I am happy to report news from **Mal Baber** whose latest check-up and cardiogram are as good as can be expected. Our best wishes for your continued improvement. . . . This note from **Alston Clark,** "This year, 1971 has been a tough one for me. Back in February I had an operation for lung cancer and in the summer and fall I had a couple of mild strokes. The lungs seem to be clear now and the only result of the strokes seems to be a slight impairment in my handwriting—so I guess I am doing all right. My energy supply is grievously diminished, but I rather assign that to old age than to disease—and there is nothing I can do about that except put up with it."

Faithful correspondent, **John Abrams** is continuing his almost one-man fight with

Los Angeles to hold back some water in the High Sierras before that wonder of nature succumbs to pollution. In part, he writes, "Am preparing for the off-the-cuff debate at the January 31 annual meeting of our ancient water association. I touch lightly on the do-nothings. Philosopher Americus who 200 years ago said, 'Ask yourself who would come to your funeral and why—to express admiration for the manner you have conducted yourself or to make sure you are dead?' February 15, 16, 17, and 18 I will be at El Centro near the Mexican border at the Geothermal Energy Conference where 250 are expected. Richard Brown who wrote the geothermal section of "Energy" in the *Review* makes the opening address. I am sending your letter to my old roommate at 104 St Botolph St., Brick Dunham.

Some time ago I received a six-page dissertation of **Tom Brosnahan**'s summer trip to the Galapagos Islands. Tom is probably our most travelled classmate. From time to time I will excerpt from his report. Tom describes the various land iguanas, penquins and pelicans found there as well as plant life. "We cruised across the Equator, around Cape Berkeley, arriving at Tagus Cove which was used by sailing vessels for centuries as a hideout."

New addresses are: M. William Weiscopf, Nassau House, 301 North Ocean Blvd., Pompano Beach, Fla. 33062; Mrs. Ching Lieh Wu, care of Mrs. Nan Chiang Shu, Chestnut Dr., Pomona, N.Y. 10970.—**Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 519 Washington St., Brookline, Mass. 02146

19

A Christmas note from **Jim Reis:** "This has been a very quiet year for me. No trip since my six weeks in Japan a little over a year ago, but hope to go back to the South Pacific again this spring." Jim adds that he'd be glad to see any of our class who gets out to California. . . . Also a fine card came from Eloise and **Leo Kelley,** and another from Iva and **Everett Doten.** Ev says "Highlights of our 1971 were our 50th anniversary and a trip to Japan and Orient." Congratulations Iva and Ev. . . . **Allegra Rodgers** sent greetings as well.

Peg and **Marshall Balfour** sent a fine letter at year end with the following news, "The Balfours continue quite pleased with their Chapel Hill, N.C., location. Bal had major surgery in the spring of 1971 and has gained 25 pounds while convalescing. In June Bal managed a conference on 'Incentives to Family Planning' for the Carolina Population Center, and continues as a visiting professor in the Public Health School for an occasional lecture or seminar. Our children are entering middle age; the grandchildren, 12 to 20 years of age, include some academic achievers."

Samuel A. Brunelle passed away in September 1971 in Holyoke, Mass. . . . **Daniel C. Hall** died December 28, 1971. His wife May wrote, "The enclosed will tell a sad story. Dan had been failing for some time. He had a cataract removed from his right eye the day after our 50th wedding anniversary and did not seem to get back on his feet again. In November he had x-rays of his head taken and found the tumor he had removed in March 1967 was growing back. At the time of the operation the tumor was pressing on the pituitary and then on the optic nerves. I'm so glad we went to the 50th for he enjoyed it very much. My best to the Class he loved, and to you." May asked that any contributions be credited to the Class of '19 at M.I.T.

Roger T. Hall, a twin brother and classmate wrote your secretary: "As for me, I am still active in the D.C.-Maryland-Virginia area in the construction field, although I retired from my own business in 1961. Living as we have for nearly 50 years on the banks of the peaceful but polluted Potomac with a wonderful view of the river, the historic C and O Canal and the Virginia hills. Would sure welcome a visit from you or any of my 1919 friends."

Francis Weiskittel writes, "My 24-year-old son entered Corpus Christi College, Oxford, England in October 1971 to begin as a freshman to study 'classics' i.e. Greek or Latin for three years, after graduating in four years from Princeton and three years of similar classics at Johns Hopkins. What can he do after ten years of such schooling?" . . . **Frank P. Reynolds** writes, "My wife and I have just returned from a beautiful trip to Honolulu where we spent a month with our daughter and son-in-law, Rudolph Preisendorfer, '52. . . . **Leighton B. Smith** sends this note: "This year we made trips to California, Utah, Michigan and Bonaventure Island. Our primary objective was to photograph birds, and we spent five weeks doing just that. Adelaide and I both enter color slides in the International Nature Salons. In October we had a very pleasant evening with Aline and **Lou Grayson** who were on their way home from Portugal. . . . **Edward A. Richardson** writes, "My son Robert was married to Patricia Logan December 11, 1971. Mary and I have reached the apartment stage, are selling the house, and temporarily renting an apartment."

Robert Burns MacMullin was presented the Perkin Medal for 1972 at the Society of Chemical Industry's annual Perkin Medal Dinner, February 25, at the Plaza, New York. Other honors won by Bob are the Professional Achievement Award, Western N.Y. section, American Institute of Chemical Engineers, and the Schoellkopf Medal, Western New York Section, American Chemical Society. Our December 1971 notes stated that Bob retired from R. B. MacMullin Associates, consulting Engineers in August, 1971. (*See picture, p. 83, this issue.*)

The New York Times, December 5, 1971, carried an article in the business section, "The Mainspring of Times, Lehmkuhl Pins Hope on Quartz Watches." **Joakim L. Lehmkuhl** founded the U.S. Time Corporation in 1949 and now as chairman of the later named Timex Corp., has about 53 per cent of the U.S. market of all watches sold at retail, 19 million watches sold domestically and 11 million overseas in 1971. It is still a private company. They are planning to issue early in January 1972, a quartz watch, accurate to 15 seconds a month and to retail under $200.

M.I.T. Alumni records announce the death of **William Pinkney, Jr.,** on February 27, 1970 in Norwalk, Conn.

Don Way, our class president, was in Florida in January with Barbara visiting her brother in Boynton Beach. I had lunch with Don on January 24 in Delray Beach and recently had a letter from him after he returned to Westfield, N..J, to 20 degree weather. . . . Your secretary had notes from Bud Fisher, '18 and Julie Howe, '18. Bud had successful hip surgery for arthritis and now swims and walks for exercise. Julie had his 50th wedding anniversary in May 1971, a trip to Italian hill towns in September terminated by Elizabeth having a broken hip. Golf and ocean swimming are excellent here in Delray Beach. If any classmates get this way please call me at 305-278-4537.—**E. R. Smoley,** Secretary, 50 East Rd., Delray Beach, Fla. 33444

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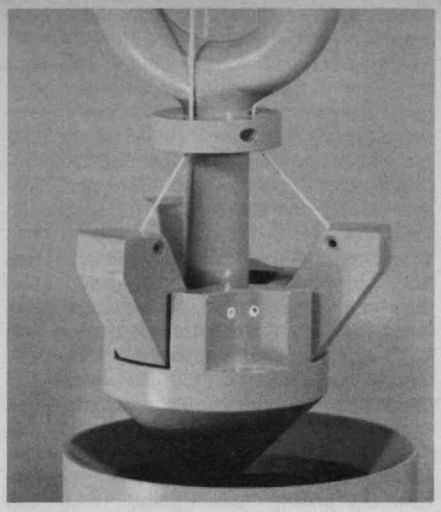
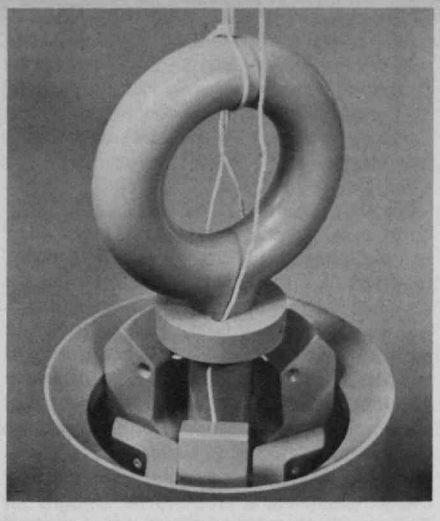
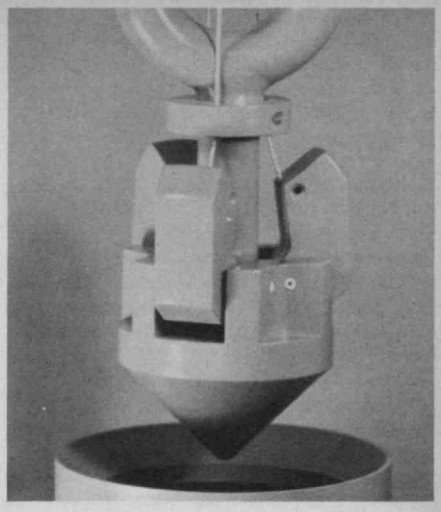
It is pleasing to report that our good classmates continue to keep busy and active and happily on the move. . . . **Ed Burdell** writes "I am interested in finding out how many of our classmates have moved to Florida as reported in your December notes, but most of them seem to hug to the Atlantic coast area."

Ed continues: "We spent the summer here in Maitland and enjoyed temperatures not much different from those heatwaves you suffer in the North. In late September, Emma and I flew from Miami to London, the perfect time to visit England. As a member of the board of trustees of our local hospital I looked into the British health and hospital system, especially the community aspects of the hospital as a genuine health center for everyone in that area. We were very favorably impressed and the authorities there couldn't have been more hospitable and helpful." . . . **Foster Doane** writes that he and Gladys drove from Neenah, Wisc., to Hollywood Beach, Fla., to spend some time with Winnie and **Frank Badger** who have an apartment there. On the way down they stopped at Cocoa Beach to see their old friend and schoolmate, Harold Bixby, '21, and discovered that **Bat Thresher** lived in the same building. Irene and Bat joined them for a happy visit. . . . **Heinie Haskell** writes that he brought his Morgan sloop down the coast and berthed it at Harbortown, Hilton Head, S.C. Heinie admits he is semi-retired as chairman of Brunswick Worsted Mills and Carved Industries, Inc. He invites classmates to check in with him if they get to the island.

Norrie Abbott tunes in with a report that while in Hartford on historical business he had a chat with **Buck Clark** who "sounded healthy." We trust Buck continues in good shape, for Amy and I have set up an Easter weekend date with May and Myron for that delightful Shawmut







A Radioactive Hook

Eight feet below a one-foot-diameter lead glass window is a U-bolt attached to a filter in a cannister. The filter is full of radioactive material, ready to be lifted from its place in the nuclear reactor coolant stream. Problem: hook the filter, lift it from the cannister, hoist it to a disposal area, and unhook it again—all without exposing workers and operators to the filter's high-level radioactivity.

For a solution, Stone and Webster Engineering Corp. turned to Wayland S. Bailey, '19, an engineer in its Nuclear Division. Realizing that a horizontal hole would be a better target for the grapple than a vertical U-bolt, Mr. Bailey modified the filter to provide a cone-shaped opening with a ¼-inch lip at its top. Then he designed an automatic, remote-controlled grapple (1) with pins to snap under the lip like a carpenter's "toggle" when the grapple seats (2) into its target. To each pin is attached a flexible steel cable; When the filter reaches the disposal area, pull the cables, retract the pins, and lift the grapple free (3).

The photographs show a 4x-size wooden grapple being lowered into a wooden grapple cylinder—mock-ups used in Stone and Webster's Nuclear Division to perfect and assure the design, which now awaits Atomic Energy Commission approval.

Inn at Kennebunkport, Maine. Norrie also reports that he and **Johnny Nash** see each other almost weekly on auto excursions around Rhode Island and adjoining territories and that John is getting along fine. On January 28, John and Kay celebrated their 50th wedding anniversary amid a flock of grandchildren. Congratulations from all of us, Kay and John, and keep up the good work. Those irrepressible and indefatigable railroad buffs, the Abbotts, are cooking up another fantastic junket, on the rails around Switzerland, Liechtenstein, Denmark, Sweden and Norway. Sounds wonderful, Betty and Norrie. . . . **Bob Sumwalt**'s handsome and distinguished countenance crops up in a Freedoms Foundation publication in which Bob is cited for his outstanding service as National Awards Jury chairman. Bob has been regional vice president of the Foundation since 1964. He has contributed extensively to the furthering of the aims of the Foundation which are to encourage citizens to become more aware of their freedoms and to work actively to preserve and enhance them.

It is a pleasure to report that **Jim Wolfson** is now in his winter quarters at 3199 S. Ocean Dr., Hollandale, Fla., having been delayed a bit by a stay in the hospital. Jim, by the way, is director and chairman of the building committee of the Peninsula General Hospital of Long Island. However, we are sure he never planned on using the new facilities which he supervised for them. . . . Earlier in the season, Lydia and **Fraser Moffat** drove from their home in the western hills of Pennsylvania to Vero Beach, Fla. . . . It was good to hear that **Harold Bennet** of 5072 Tennyson St., Denver, has improved in health and is able to enjoy his many hobbies. . . . **Ralph Larsen** has left Wilton, N.H., and is now in Dover, Mass., at 45 Tubwreck Dr. . . . **Jacob Novack** is now in Brookline, Mass., at 100 Centre St. . . . Belated acknowledgement is hereby extended for the delightful Christmas messages received from Denise and **K. B. White** from Chateau D'Arthies, Magny-en-Vexin, France, and from Chi-Shih and **Ming Pai** of Washington, D.C.

Our Class mourns the death of **Ralph Spencer** of 103 Winter Dr., Sikeston, Mo., in December. Ralph had long served as State Highway Commissioner. . . . Another civil engineering graduate, **Winslow Wetherbee,** died in August of last year. Winslow lived at 416 Rogue Valley Manor, Medford, Oregon. . . . Two distinguished educators of the Class have also left our ranks—Professor **Edward S. C. Smith** of Gainesville, Fla., and Professor **Senichi Fujimura** of Yokohama, Japan, a graduate of Course II. Professor Smith was emeritus professor of geology at Union College, Schenectady. All of the above served with distinction and were a credit to our Class.

Through the kindness and thoughtfulness of **Vera Howes,** I am able to add the following information about the illustrious career of our Homer whose passing was covered in the January notes. After retirement from business Homer was made a trustee of Fisk University, Nashville, Tenn., and later became chairman of the board. With characteristic energy and devotion to duty he travelled extensively and attended many meetings relating to higher education, his warm personality attracting many friends and admirers in this entirely new field. He held the position of chairman emeritus at his death. The Bemis Co. publication announcing his passing, contains the following description of Homer, "He was not only recognized as an outstanding leader within the company but was widely known for his contributions to the textile bag industry and served as president of the Textile Bag Manufacturers Association. Born in Brookline, Mass., he joined Bemis in the same year he graduated from M.I.T., as assistant auditor. He became manager of the trade extension department in 1934 and was elected a director of the company in 1941. The following year he was appointed director of sales and was later made a vice president."—**Harold Bugbee,** 21 Everell Rd., Winchester, Mass., 01890

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Some thinking has now started on another interim reunion to be held, perhaps in Florida, in February or March 1973 or 1974. This might include Disney World, Everglades National Park, fishing, golfing and swimming. **L. A.** (Al) **Lloyd,** 35 Spruce St., Westerly, R.I., has agreed to continue as interim reunion chairman and would welcome suggestions as to date, location and program. No big deal is contemplated—just another opportunity for this wonderful class of '21 to continue friendships built up over the years. Write Al your opinions and suggestions and include some news for this column.

World Traveler

Saul M. Silverstein finished his 78-day trip around the world (Safari number 33) late in January. This was a combined business and pleasure trip as most of his trips have been. On these trips he participates in management seminars and conferences, lecturing and consult-

Saul M. Silverstein, '21

ing in the countries he visits. Saul was named a member of the International Council for Scientific Management (C.I.O.S.) in March 1971. The latest trip took him largely into the Middle East and Far East with return via the Philippines and Hawaii. While in Seoul, Saul had a hotel luncheon with two Korean families. After lunch there was singing of Christmas carols and later "Rabbi Silverstein said grace and pronounced benediction." Saul visited three schools on this trip and talked to the children. In Istanbul, meeting with 29 Turkish youngsters (8-11 years old) he faced a lively question and answer period. Why did U.S. build atomic bomb? Why go to the moon? How is U.S. governed? What are differences between U.S. and Turkish schools? Why our conflict between black and white? How are jobs assigned? At a similar session in Jerusalem with 12-year-olds: Why does U.S. insist on our giving back land we won fairly in six-day-war? Will U.S. come to our aid if Russians attack us? Why do you take time to visit school children? Saul told them a "U.S. class he visited was mostly interested in material things; a Japanese class in national pride; a Turkish class in science and an Israeli class in social-political problems." A most interesting account from which we could only take small excerpts.

In Honolulu, visiting by phone with Catherine Field, Saul learned that **Harry Field** is having health problems and is now in a health center.

Correspondence

Late in November your scribe sat down and wrote 16 individual letters to classmates seldom or never heard from. This brought forth four replies. **Alexander Lapointe** of Birmingham, Mich., wrote that he retired from Ford Motor Co., in 1963 and is now a consultant "engaged in a peculiar phase of the automotive coatings business, namely the recycling of coatings derived from spray booth sludges." He presented a paper in Chicago in December at an international seminar concerning itself with anti-pollution problems in the industry. . . . **Austin Kirkpatrick** of Hyannis, Mass., reports that he is in good health and enjoys living away from the big cities. Your secretary remembers that Kirkpatrick lived on the fifth floor of Runkle Hall at M.I.T. while on the sixth floor (with no elevators) were John Barriger and Jack Rule, your secretary and Hobart Fischer '22. Fourth floor Runkle had Willard Loesch and the late Sanford Hill as roommates and Glenn Fargo who ran those wonderful dorm dances.

W. Hoyt Young of San Marcos, Calif., writes that after graduation he first used his engineering in the manufacture of oil gauges for Model "T" Fords. In 1930 he entered New Jersey Law School, got his L.L.B. degree and was admitted to the bar. He worked as a patent attorney until World War II, joined the navy and became chief inspector of hydraulic ship components. He attained the rank of Commander, U.S.N.R. After the war he opened a patent attorney's office in San Diego, Calif. As a sideline he bought an 88-acre-ranch with fruit groves, studied agriculture under the G.I. bill, and became a fruit farmer. He retired from patent law at age 65 but continues his farming on a smaller scale. . . . Mrs. **Frederick W. Adams,** 269 S. Prospect Ave., Clarendon Hills, Ill. 60514, writes that Fred is in a nursing home following surgery in June 1969 and again last August. He retired as director of (chemical) research with Continental Can Co., in March 1966. Fred has three fine sons and five grandchildren. His recovery has been slow. Please write to him at his home address. . . . Reminder: 12 of you did not reply to my letters. How about it?

Philip T. Coffin wrote from his winter address in Naples, Fla., to Bob Miller, Cac Clarke and your secretary asking if we could identify all the men in the class picture on the Sloan Building steps last June. If successful in this endeavor, he will mail out a key to this photo to all the '21 men who attended our 50th reunion. . . . **Munroe Hawes** of Sea Girt, N.J., sent a note in November telling of the return of their son George from Vietnam. A helicopter pilot and captain in the Marine Air Corps, he was awarded the Vietnamese valor medal and the Distinguished Flying Cross. Congratulations! . . . Two long letters in late fall from **Richmond S. Clark** to Cac stated his belief that he had known Ray St. Laurent longer than anyone else in '21. Their friendship started in 1914 at Boston English High School where Rich became president of his class in his senior year. He recalled a skating party with Ray on Franklin Field where the third member of the party was a Helen MacKenzie. Helen, of course, became Mrs. Raymond St. Laurent. Rich writes that health restricts him somewhat and that daily pills, as with most of us, are a way of life. He and his wife Mary Louise take short trips and spent last July on his boat in Galveston.

Christmas Jottings

Various bits of news came in at Christmas to Cac Clarke and your secretary. . . . **Dave Woodbury** of Ogunquit, Maine, reported operations last summer prevented attendance at our 50th. Marion and **George Chutter** stopped in to see Dave and India Woodbury in November and report that Dave is "much better." . . . Celia and **Frank Huggins** of Frogmore, S.C., sent out a family Christmas letter bordered with Frank's delightful sketches. Frank claims they lead an indolent life but your secretary has seen the farmhouse alterations going on and Celia's plantings of azaleas and camellias—neither the product of indolence. . . . Eddie and **George Gokey** shoved off for St. Marten in January—their fifth year at the same place.

Elma and **John Mattson** sent out a poem at Christmas covering their year's activities. A trip from Maine to Florida Keys involved 5,000 miles of driving and accompanying sketches showed the landmarks visited. . . . **Eric Smith** of Montreal, Canada reported a trip with his sister to Waterton Lakes Park in Alberta and Prince Albert Park in Saskatchewan. He said its' a "big change from the prairie trails I knew." . . . Ruth and class president **Irving Jakobson** took off for a February vacation at St. Croix, Virgin Islands. After they return, Jake has plans to come up from Florida via the inland waterway with Don Carpenter '22. . . . **Dugald Jackson** of Havre de Grace, Md., wrote that he spent two days attending a Northeast Republican conference in Washington, D.C., in November. A talk by Vice President Agnew and a White House reception with Julie Eisenhower as hostess, were highlights of the affair.

With sadness, we report the death of two of our classmates: **Henry P. Harris** of Collinsville, Ill., and **William H. Hopkins, Jr.,** of Pasadena, Calif. The sympathy of the Class is extended to their families.

New addresses have been received as follows: Dana A. Barnes, P.O. Box 1019, Morrow Bay, Calif. 93442; Wolfe W. Brown, 1401 Drexmore Rd., Cleveland, Ohio 44120; William R. Mathews, E 104-31st Ave., Spokane, Wash. 99203.

With this issue, two new Assistant Secretaries are being welcomed aboard to assist in news gathering. My thanks to them for being willing to help.—**Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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Winter finally arrived in Buffalo with snow to keep the skiers happy but not enough to disrupt traffic. Your secretary will spend two weeks of February in Florida prior to his Chamber of Commerce Round-the-World trip in April. This is in preparation for the 50th reunion at M.I.T. in June. All kidding aside, the plans for the 50th are thoughtfully and joyously completed to the last detail—you have received President Parke Appel's letter of details. First make your big contribution *now* as requested by **Dale Spoor** and **Don Carpenter;** then complete the confidential survey, order your reunion blazer with '22 crest and finally make reservations and get ready to take off for Cambridge on or about

May 31 or June 1 . . . . Madeline, Joan and **Parke Appel** plan to be in Venice, Fla., for February and March. They will all be ready to promote reunion-good times upon their return in April.

Elizabeth and Col. **C. B. F. Brill** visited V. G. Brinton Thompson in Bar Harbor in August and spent last September in Portugal . . . **Max Salomon** of Johannesburg sends greetings to **Clarke T. Harding, Tom Shepard** and to **Oscar Horovitz** who arranged an M.I.T. meeting in South Africa some years ago. He has seen only two classmates during the years, Bill Brackett of West Virginia in 1955 and **Fred Koch** in Joburg a few years ago. . . . We have again received reports of **Martha E. Munzer**'s talk before the Third International Conference of Women Scientists and Engineers on the subject of a liveable environment. Her book, in preparation by Alfred Knopf is *Block by Block—The Rebuilding of a City.* . . . **C. Hall Baker** is still running a real estate and appraisal business in Cape Elizabeth, Me. . . . **Bertha S. Dodge** of Burlington, Vt., has retired as president of the League of Vermont Writers. She is now chairing an awards committee offering prizes for excellence in writing with several other fine authors acting as judges. She encourages classmates to join this year's competition of nonfiction works of 5000 words or less. . . . We are happy to welcome the **C. George Dandrows** to Bronxville, N.Y., for the winter. We hope to see them at the 50th. . . . **Margarethe Spalding** enjoyed the celebration of the Cincinnati Centennial with her daughter Carol and family. Carol and Bill entertained a large group in their historic old home during the affair.

The sympathy of our class is extended to the families of **Ralph Cook** of Long Meadow, Mass., and **Eugene R. Rowell, Jr.** of Pascagoula, Miss.

Among the changes of address received are Irving Brams, Clearwater Beach, Fla.; Myron K. Lingle, Springfield, Ill; Harold Stanley, Hillsboro Beach, Fla.; Irving Ball, Atlantic Beach, N.Y.; Lee W. Carroll, Newark, N.J.; Laurence R. Culver, Satellite Beach, Fla.; George W. Dakin, Exeter, N.H.; Henry J. Fagan, Horseheads, N. Y.; Leo H. Freedman, Plattsburg, N.Y.; Charles L. Gilkeson, Harrisonburg, Va.; Harvard E. Moor, Bangor, Me.; Edward J. O'Connor, N. Andover, Mass.; Russell F. Schreiber, Springville, Pa.; and Frank L. Youngs, Mesa, Ariz. . . . Remember, as you finish these notes to: (a) contribute to the 50th gift; (b) order blazer; (c) send registration fee; (d) buy airplane ticket or fill your car with gas; (e) be at M.I.T. for our 50th reunion on June 1 for hale and hearty greetings from a bunch of swell people. See you there! —**Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar H. Horovitz,** Assistant Secretary, 3001 South Course Dr., Apt. 103, Pompano Beach, Fla. 33060

23

To start with we have the following important message from **Arthur W. Davenport,** our Class Historian, "I would appreciate your good assistance in the next issue of *Technology Review*. There are approximately 40 of the 350 that receive the *Review* who have not responded to date. However, to add to the accuracy and to complete the value of *The Great History of The Great Class of 1923,* we need their assistance. Please request them to forward to me immediately their biographical record which we have requested on two previous occasions. If these 40 do not have a copy of the format for the material desired, have them advise me at once—A. W. Davenport, P.O. Box 574, Virginia Beach, Va., 23451. It is later than you think!"

George W. Bricker moved last August from Wilton, Conn., to South Chatham, Mass. George is still active in management consulting having recently finished a report to the United Nations on the subject of "Natural and Synthetic Rubber." He is also noted as the author and editor of Bricker's *Directory of University-Sponsored Development Programs* (in management). **William Glendinning** is still active in continuing educational activities for engineers needing refresher courses for professional engineers licenses.

Jacob A. Elfenbein advises that he developed the first practical, simplified electronic computer system for determination of center of gravity for aircraft. This system, for which Lockheed Aircraft has sole manufacturing rights, is being increasingly used by air cargo carriers. From a letter to Pete Pennypacker we learn that Colonel **Walter E. Richards** was hospitalized last April (1971) due to a serious kidney ailment but is now OK after a considerable loss in his avoirdupois. . . . On the subject of our 50th Reunion, a letter will soon go out to all of us from **Herb Hayden,** outlining the tentative plans, the dates (May 31-June 4, 1973) and the location (Marriott Hotel on Route 128, near West Newton) and provision for limited housing at McCormick Hall for those desiring to be in closer proximity to the Institute.

From **Percival S. Rice** we have learned of the death of **Robert E. Hendrie** on January 13, 1972. As most of us will remember, Bob was most active in track sports and was on the varsity track and varsity cross-country teams during his last three years at the Institute. He won the "T" with three stars and was also in first place in the New England Cross Country Race in 1922. He also won first place in the New England two-mile in that year. Perc Rice goes on to say "I think he was one of the finest men I have known." Bob also played the violin in the Tech Show orchestra. His career was with the New England Telephone and Telegraph Company. . . . Indirectly we have also learned of the death of **Alberto Lobo Guerrero,** in Bogota, Colombia on May 2, 1971, from his daughter who writes—"With great sadness I write to tell you that our dear father passed away. He had been ill for the past six months and finally his heart failed."

We are also sad to learn of the death of **Erwin G. Schoeffel** on June 13, 1971. Erwin was born in Rochester, N.Y., in 1899 and attended the local schools there. He joined the Aluminum Company of America in 1924 as a chemical engineer and had various positions with that company until he retired as manager of the Massena operations of Alcoa in 1964. In 1926 he married Miss Majorie Sibley of Worcester, Mass., who passed away in 1963. Surviving him are his second wife, a son, a daughter and five grandchildren. He was well liked by his business associates and active in many social and community organizations. . . . Further deaths reported, without detail, include—**Oswald J. Kirchner** on February 17, 1970, **Gordon S. Crispin** on April 22, 1971, **Stephen Webber** on July 13, 1971, **Thomas J. Hails** on November 30, 1971 and **Philip M. Stearns** on December 12, 1971.

Our peripatetic classmates continue to move about, as follows: R. Kirk Askew, Jr., RD #1 East Greenville, Pa., Ernest L. Akerley, 6307 Berwick, No. Madison, O., George W. Bricker, Jr., Forest Beach Rd., South Chatham, Mass., Walter Dietz, P.O. Box 2265, Delray Beach, Fla., Jacob A. Elfenbein, 1273 Westwood Blvd., Los Angeles, Calif., Luis R. De Luzuriaga, Time and Life Bldg., Suite 3720, Rockefeller Center, New York, N.Y., L. Melvin Nelson, Jr., 1500 Hinman St., Evanston, Ill., Albert H. Steinbrecher, 4538 Camino Molinero, Santa Barbara, Calif., Frederick B. Stevens, 909 San Carlos Cr., Ft. Myers, Fla., Dr. Julius A. Stratton, M.I.T. Room 14N-112, Cambridge, Mass., William R. Tayler, 651 E. Front St., Plainfield, N.J., Atherton Thomas, P.O. Box 419, Carmel, N.Y., Philip H. Vivian, P.O. Box 1295, Stuart, Fla., and Elwood A. Windham, 2 Merry Mac Loop, Clinton, Conn.— **Thomas E. Rounds,** Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Conn., 06810

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While your Class reporter wishes to feed you a broad coverage of news about our members, it seems that information reaches him from a limited number. A further problem arises when articles arrive just after the deadline and must be held over. Material must be in my hands at least two months before publication. Should anyone like to propose a means of reducing lead time, the *Review* will be happy to study it.

Our affluent brothers in Florida, stimulated by orange juice, sunshine, and ennui, seem to have developed an esprit de corps that blossomed into the First Florida Fiesta on March 3, at Naples. It was hosted by **Paul Cardinal** and **Pret Littlefield.** No report at this writing, but the potential was 38 Floridians. . . . I heard that two Yankee spies, **Frank Shaw** and Barbara, had planned to infiltrate. . . . **Ray Lehrer** and Dot took off from Newton on January 27 for their three-month world safari but were scheduled two days too early at that locus.

A very unusual Christmas card from **Nish Cornish** and Luisa also noted the "24th Annual M.I.T. Fiesta in Mexico" March 16, 17, and 18 with bulletins and a hope that your scribe and partner might make it. Sorry that we could not, but **Gordon Harvey** and his frau are coming. They were also optimistic that I might land in Ft. Lauderdale and submitted a very detailed sketch of their hacienda

location. . . . Before moving from Florida, we have had word from **Emilio del Prado** that several of his children and grandchildren are living there and in South Carolina. As I interpret Del's letter, he is still a Professor at Feati University in Manila but also raises hogs and plans to expand his holdings to 300 sows this year. Our records indicate his degree was in mining and metallurgy and I can only conclude that he refers to sandhogs or pig iron.

Bill MacCallum and Eleanore spent two weeks in Hawaii in January and sent a most unusual syndicated article about Puerto Rico which concluded, "Much of the credit for its bubbling vitality probably should go to Puerto Rico's remarkable governor **Luis A. Ferré.** At 68, he looks 10 years younger. A pianist of some distinction, over the Christmas holidays, as his own tribute to Pablo Casals (his 95th birthday at San Juan), Ferré learned the Beethoven Sonata, Opus 69, for piano and cello." The A.S.M.E. at its Annual Banquet in Washington, D.C., on December 1, 1971, conferred its Hoover Medal on "Luis A. Ferré, Fellow A.S.M.E., Governor of the Commonwealth of Puerto Rico, eminent engineer, humanist, prescient statesman and builder of industry, zealous servant of his people, munificent philanthropist, devoted patron of the arts, fulfilling his public trust with an innate sense of social justice and an intense dedication to the welfare of the people of his country."

And from **Austin G. Cooley,** our facsimile expert, "My latest facsimile project was accomplished without any aid from Hoffman-LaRoche." He authenticates this with a typical Patent Office application with three sketches of Donna Joyce born November 20, 1971, in Reno, Nev. Litton Industries is currently supporting him on facsimile projects. . . . **Gilbert W. Noble** signs his Alumni Fund envelope as '25, but our records classify him as 1924, living in Winter Park, Fla. "Busy in retirement with stable of racing harness horses and stamp collecting hobby." . . . Other Fund envelopes have reached me but lack post-marks, leaving your reporter in the dark on source location. However, **Webster Brockelman** seems to live in Framingham, Mass., and writes, "My best for 1972 to all '24ers. I am retired but still keep a small finger in as Chairman of the Board, South Middlesex Bank." . . . From Jersey City, N.J., **E. Curtis** (Dean) **Plant** appears to have established a service record—47 years with Public Service Electric and Gas Co. of New Jersey. He expects to continue residence in New Jersey and be active in several civic organizations and as a Director of First Savings and Loan Association of Jersey City. Dean was a Lieutenant Commander, U.S.N.R., now retired.

Paul G. Blampied, Johns-Manville retiree and avid yachtman, is shifting to a comfortable freighter for the next four months and leaving the driving to the skipper of the Dutch "Neder Epro." Paul's mate, Dot, won the argument against another winter in Florida, and he expects to reduce passage cost by the saving on cheap liquor and tobacco. Only regret is that golf is not available; but after leaving Galveston and arriving in Osaka for a few rounds, he might look up Takashi Murikami, who faltered in the San Diego Open in January. So we have another 'round-the-world voyager competing with Ray Lehrer. . . . Our dynamic President, **Ed Moll,** is working on a top priority item—the design and construction of a display cabinet for Chick Kane's stein collection, so graciously donated to the Class by Betty Kane. The proposed location in the Faculty Club is awaiting approval.

On January 11, **Jack Hennessy,** our Fiftieth Reunion Gift Chairman, hosted a number of our members at a luncheon in the sumptuous new quarters of Syska and Hennessy in the new Standard Oil Building in New York. Plans were discussed for accelerating commitments from individuals and industry, although we already have $120,000 cash in hand toward a $750,000 goal.

Your Class officers are receiving pros and cons relative to the 1974 Reunion on campus, but we want the thoughts of many more. Please express yours to me, supported of course by logic. Any off-campus site must be reserved immediately.

Richard T. Lassiter retired June 30, 1971, from Arthur G. McKee Co. For the last three years his office was placarded "Consultant," for which he was well qualified on the design and construction of mineral processing plants, including international projects. Dick is a registered professional engineer and Fellow of the American Society of Civil Engineers. His latest literary effort is "Pollution and Mining." Along with his vocation, he has been a tireless worker for Phi Mu Delta, which recognized his accomplishments last August by electing him to their "Distinguished Service Chapter."

Herb Stewart and Winnie were off to Mobile, Ala., for a committee meeting of the A.I.E.E. February 8 on the subject of electrical systems and equipment. He will present a paper on "Fast Valving of Steam Turbines." They will hire a car and look over northern Florida and visit a few classmates. Herb recently attended the New York annual meeting of the U.S. National Committee of the International Congress of Large High-Voltage Networks, preliminary to the Biennial Convention at Paris in August. The uninsulated nudes of the Folies Bergères apparently do not shock him, as he has been a regular Congress attendant since 1960.—**Russell W. Ambach,** Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

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"No news is good news", so they say, but this does not hold for a class secretary. So I shall try to make do with the few gleanings I have and hope for something more in the future. A letter was received from **Masaru Kametani** in Japan asking me to forward copies to **Doc. Foster** and **Sam Spiker**—a request that I performed with pleasure. His son has been attending a training course in the U.S.A. and had an opportunity for a weekend visit to Cambridge. Kami sounds as busy as ever and wrote about a trip here in January, but I do not think that this materialized. . . . **Finlay G. Cameron** writes that he is retired from his Illinois and Saigon jobs and that he and his wife have moved their home to Coronado Shores on the Pacific across the bay from San Diego. . . . **Don Taber** is mostly retired spending about three mornings a week at the office during the eight months he is in the North. In winter he enjoys a lazy existence at Boca Raton, Fla.

R. T. Lassiter, '24

L. B. Grew, '27

Edwin T. Erickson has been with the City of Newark's Division of Water Supply since 1927 and is division engineer in charge. He served for one year with the First Infantry Division as engineer captain, training at Fort Devens, Mass. He has three sons, each with two children and now three grandsons and three granddaughters. . . . **Douglas B. Martin,** in search of more activity after retiring from the Chrysler Corp. in 1966, joined the Masten Corp. of Chicago and is now district sales manager at a branch office in Warren, Mich.

I am sorry to have to report the death of **E. Irvin Richardson** of Manchester, N.Y. July 24, 1971.—**E. Willard Gardiner** (Will), Secretary, 53 Foster St., Cambridge, Mass. 02138

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One evening John Kiernan, the naturalist, who lives in town, was here for cocktails and asked if we had seen any eider ducks. Not being a bird-watcher I remarked that I'd seen some black and white ducks in a group of other ducks swimming in the ocean out front. I'd answered Mr. "Information Please" correctly without realizing it, so I asked him one—"Do you know **Dick Pough?**" Why of course, our illustrious naturalist classmate is an old crony of John's.

No longer is your Secretary the only residential '26 man located here—**Mal Hird** is now a local citizen. Mal's brother-in-law is the local postmaster and he told me some time ago of Mal's impending arrival. Recently Mal asked for **Ariel Horle**'s address in El Paso and they have already been in communication and plan to get together this summer when Ariel comes north.

Starting the notes with a non-retiree, **Al-**

bert L. Entwistle writes, "Wish I could retire but working harder than ever with my Howard Johnson program." . . . **George V. Steele** writes, "As an interior decorator about the only thing that interests me in the *Review* is the Class Notes. They can be quite nostalgic. My son and his wife have just moved to the north shore not too far from Pigeon Cove. Mama and Poppa remain in Dedham." . . . The next classmate, **Bill Davidson,** has retired. In his words, "Have retired after 42 years in Bell system. Last ten as Vice President-Engineering and Planning, Bell Telephone Co., of Pennsylvania. Expect to winter in Sarasota, Fla. Ran into several M.I.T. men in the Sarasota area but none from '26." . . . **Charlie McHugh** comments, "I retired as Director of Research, Raybestos Manhattan Inc., January 1, 1969. I am now on the faculty of one of the State Colleges a couple of days a week and enjoying it. . . . We must not let an issue go by without reporting on our illustrious classmate, **Stark Draper.** This month's medal for Stark is known as the Rufus Oldenburger Medal "in recognition of his notable contributions to navigation through gyroscopes of his own design and for outstanding teaching." Stark's medals now number in the forties!

Now for an important announcement regarding our 50th reunion. After a convincing proposal by Class President, Dave Shepard, **Don Cunningham** has accepted the chairmanship of our 50th reunion. With a couple of successful reunion chairmanships and active participation in organizing every other reunion, Don has the credentials required for this reunion of reunions. For the Class we express our appreciation to Don for his acceptance and for his fine direction of our 45th.

Well the hi-fi has just announced that it is National Kraut and Frankfurter week so it certainly is time to shut it off and say Cheerio!—**George Warren Smith,** P.O. Box 506, Pigeon Cove, Mass. 01966

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There will only be these notes and the next for me to emphasize what real satisfaction comes from attending our class reunions. Five years ago, the feeling was unanimous that the renewing of acquaintances had been totally worthwhile and rewarding. **Bob Bonnar** is writing to those who were there in 1967, and a general invitation will go out to all classmates. The dates are June 2, 3, and 4; the place—Bald Peak Club at Wolfboro, N.H. What can I add except: You be there and you won't be disappointed. And all this goes for the wives, too.

Charles V. Bullen, we regret to record, died February 27 in Dallas, Texas at the age of 76. He graduated from the University of Texas in the class of 1920 with a B.S. in electrical engineering. He earned his master's at Tech in 1927. From 1932 to 1960, Professor Bullen taught in the department of electrical engineering at Texas Tech College and at the time of his retirement was head of the department, and professor emeritus.

Larry Grew had been with Southern New England Telephone for 43 years, beginning in 1928 as a engineer's assistant. By steady steps, he became general transmission engineer in 1965 and five years later, engineering manager—facilities requirements. Larry writes that he is keeping his Connecticut professional engineer's license to see what use he can make of it. What he does is going to depend a lot on whether he gets bored being handyman at 21 Yowage Ave., in Branford, Conn. If other experiences are any guide, he will find plenty to do.

Ken Smith sent some news with his Christmas card. (These are the first notes which have been due since mid-December.) Last August he went to Scotland, visiting many relatives. He had not been there in 24 years. He comments that that is a poor month in which to see people. All on holiday or somewhere else. **Amund Enger** wrote to Ken that he had been to Portugal and was about to go to Norway. As to the future, Ken will still be dean of the school of architecture at Columbia University for this academic year. After that, it's maybe.

In the January notes, mention was made that **Harland Sisk** was involved in S.C.O.R.E. His specific job is chairmen of the Cape Cod S.C.O.R.E. chapter, which means that he and other members of the chapter are giving voluntary help and advise to local small businessmen, under the sponsorship of the Small Business Administration. . . . **Phil Darling** is busier than ever: "With partner, after over a year, have completed survey for Republic of Venezuela of a cellulose industry—prefeasability study—most fascinating study and country. Upon retirement, made two promises: number one to Dora—no work requiring travelling, number two to me—no work involving management. Ergo, your assistant general manager just back from a two-month stint. Suggestion, if you're bi- or multilingual, keep your trap shut about it." . . . Another still-active retiree is **Ed Cahill,** unretired petroleum geologist. . . . A good report from **Al Billings:** "Still enjoying retirement (at a slower pace). Active in local (Cumberland, Md.) historical society and civic affairs, as well as antique hunting and a little buying and restoring. Some short travel trips and visiting children and families. Hope to attend 45th Class Reunion in June at Bald Peak."

Address changes so often involve a guess as to what is involved. . . . **Ed Dunn** who has lived so long in Hartsdale has an address now c/o F. M. Forwood. Apt. A-405, 1300 No. Harrison St., Wilmington, Del.; **Winfred Witham** has moved from Aptos to Fresno, Calif. at 1382 W. Sample; **Edward Wells'** address at Hilton Head Island, S..C, is 111 Mooring Buoy Rd.; apparently **Russell Taylor** is spending at least some of the winter in Florida, at C 116 Test Harbor, Ft. Lauderdale, P.O. Box 1660; thought we had **Howard Ferguson** all ser in Hendersonville, N.C., but now he shows up with an address at 1008 Apollo Beach Blvd., Apollo Beach, Fla.; **Charles Carr** has moved from Verona, N.J. to 85 No. Pocono Rd., Mountain Lakes, N.J.—**Joseph S. Harris,** Secretary, Box 654 Masons Island, Mystic, Conn. 06355

28

One of the best gifts a class secretary can hope for is a nice flood of correspondence. Appropriately, this always happens at Christmas time when the local group shares its holiday mail. Greetings this year were so many, it is impossible to list them all. Sincere thanks go out to all.

Letters or notes that were included in some cases provided the following news items: **Trudy Francis** has taken up modeling and is now both in practice and teaching, all of which she thoroughly enjoys. In addition she has taken up jewelry work in silver. . . . **Lazarre Gelin** says he expects to retire this spring but will remain active as a consultant. He plans to be at the 45th for sure. . . . The outstanding event in 1971 for Olive and

Newton Foster was a three-week 1,500 mile trip through Switzerland and Austria with brief excursions into France, Germany, and Italy. Newt also reports that upon retirement from Congoleum Industries, after 43 years of service, he joined the firm of Burns and Roe, consulting engineers, for a few months as a change of pace. . . . **Shikao Ikehara** reports that New Year's day and the several following are busy festival days in Japan. Even Christmas has become a big occasion for the shopping centers in recent times.

Wife Perry, writing for **Dick Hoak,** says that Dick does some reading and enjoys hearing from friends. They hope to spend a few months in Florida where the climate is both agreeable and helpful. . . . **Paul Johnson** says his hips are well now, he is walking normally and back at playing poor golf. His wife Dorothy had to undergo similar surgery on one hip recently but she is progressing very well. . . . Louise and **Ernie Knight** were planning another freighter cruise, this time to Morocco, Tunisia, Libya, Lebanon, Turkey, and Greece. Their son Paul, who had been stationed with the army in Thailand, returned home unexpectedly in time for Christmas. Son David is an assistant professor in the School of Veterinary Medicine at the University of Pennsylvania.

Anne and **George Palo** write that they had a busy year with travels from Alaska to Athens and Yugoslavia. They rate Alaska as one of the world's top natural attractions (when the weather is good). . . . From **Rene Simard:** "I am now in my last year before retirement on November 1—no special plans yet."

Verna and **Rudy Slayter** report that their son and his wife have adopted a Korean baby girl to be sister to granddaughter Elsbeth. . . . Betty and **Dud Smith** took a 35-day tour of the South Pacific early in 1971. They liked New Zealand best although everything else was most enjoyable and interesting. . . . **Ed Ure** wrote that he had attended a reception for President Wiesner at the Metropolitan Museum in New York and there saw Bob Cook, Bob Krummel, Bob Murphy, Bill Murphy, Bill McClintic, and Lazare Gelin. Ed also sent in a news clipping relative to George Palo who was one of eight engineers made honorary members of the American Society of Civil Engineers last year. . . . Dorothy and **Herb Swartz** are pleased to announce they have a granddaughter at last; name is Jessica. . . . **Ray Wofford** says his health is good and that he plays golf four or five times a week plus monthly matches with other clubs nearby. He has just been elected president of his own club. Edith is also very busy with social activities and church work.

Jim Donovan wanted some diet advice so, of course, he wrote to our class expert. **Bob Harris** replied with a wonderful letter answering Jim's questions and giving an account of his own activities. After retiring from the M.I.T. faculty, Bob went to the University of Minnesota as visiting professor of health sciences and there taught courses in nutrition sciences to medical and dental students. He then went to U.C.L.A. as visiting professor of oral biology and taught similar courses. At the time of writing he was planning to return to University of Minnesota for further teaching of dental students. Bob says, "This is a wonderful way to slowly move into retirement. The secret of happiness is to be useful to others. The secret of retirement is to continue in contact with the young." . . . We have received several envelope panels from the Alumni Fund Office with the following news items: **Don Sturznickle** says "Texaco requires me to retire January 1, 1972. We expect to retain our home in Houston until we decide where else we might like to go."

We have a welcome note from **Frank Sweeney**: "Still enjoying life and family—retirement at 65 comes in March '72 after which I hope to improve my golf handicap." . . . **Jim Tully** and Sue ('30) do some traveling but also find fun in restoring an old New England homestead. They are retired and living in Fryeburg, Maine. . . . From **Don Perry** we have this short and cheerful message: "I was remarried in June 1971 and to the former Vera E. Bruce."

Dennistoun Ver Planck writes "I retired February 1, 1971 from Gulf General Atomic where I was manager of the gas cooled fast breeder reactor project. I am continuing to work there as a consultant." . . . **Ev Lester** reports: "I retired July 31, '71 as vice president from Foster Wheeler Corp., but continue to live at the old address." . . . From Manchester, Conn., **William Bayer** writes us: "My consulting engineering firm is flourishing; we are specializing in precast and prestressed concrete in this area. I hope to begin construction of our new home this spring on a hill overlooking the Connecticut River valley." . . . In a note to **Charlie Worthen, Monte Burgess** says "Thanks for your compliments as a supporter of the Fund. My wife and I are off on a motor trip to Mexico over the Christmas season. We are all well. Keep up the good work!"

The tragedy of **Frank Stetson**'s death brought to us notes from his wife Mildred, **Bill Murphy,** and **Bill Phillips.** On August 24, 1971, while on the way to work, Frank was attacked and robbed by a gang of four punks at a subway station in New York City. He was knocked down a flight of metal stairs and received injuries of which he died a few hours later. Frank was warmly regarded and held in very high esteem by his associates at Con Edison. A statement, signed by 53 of his coworkers, expressing their sorrow and outrage was sent to the editor of the *New York Post.* It was published in part in the September 1 edition.

Both **James White** and **John Connelly** were thoughtful in sending us information on the death of **Gerard V. Patrick** on December 20, 1971. Gerry was president of the York Division of Borg-Warner Corp., from 1963 to 1970, then chairman of the board until he retired in March, 1971. He was active and prominent in many community services in York, Pa. Besides his wife, Martha he leaves three grandchildren and two sisters. Our sympathy goes to his family. . . . We regret to report also the death of **Clarence E. Gregory** on June 8, 1971. The information has reached us belatedly. Clarence lived in New Bedford, Mass.—**Walter J. Smith,** Secretary, 209 Waverly Street, Arlington, Mass. 02174

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A small group of Twenty-Niners had an informal dinner meeting on December 13, 1971 at the M.I.T. Faculty Club arranged by Frank Mead. Among those present were **Frank Mead** and his wife, **Paul Donahue** and his wife, **John Rich** and his wife, **Jerry Gardner** and his wife, **Mal Hubbard** and your secretary. Elizabeth Hubbard and Helen Dinjian were unable to attend because of illness. During the course of the evening, a tentative plan for a Florida reunion at Orlando for three days in February was formulated. But the plan was later abandoned because reservations were not available at the Bay View Country Club for more than one day. Mal Hubbard was appointed as Class Treasurer to replace Ed Farmer whose untimely death has been reported. As usual, the group enjoyed seeing old movies of past reunions. Mal is still active and working at M.I.T. as a consultant at the Education Research Center giving the equivalent of five to six days per month. His duties are more administrative than technical, though he is involved in some design problems as well. For the past six years he has been commuting from his home in Newton to M.I.T. by bicycle. He estimates that he has logged approximately 3,000 miles during that period, which he believes helps him to keep his waistline down to normal size.

I regret to inform you of the death of two of our members, **Ernest T. Peverly, Jr.,** of Hyde Park, N.Y., on September 25, 1970 and **George F. Crotty, Jr.,** of Wollaston, Mass., on July 1, 1971. Ernest had a long distinguished career with I.B.M. since 1945. His work covered all phases of design and detailing of the company's 407 and 408 tabulators, worked on the early design and development of the selectric typewriter, design engineering on the I.B.M. Bank Machine program, design work on "Thrift", a low-cost tape drive and design and development of high-speed tape drives. George F. Crotty, Jr. was an executive in the Department of Employment Security, Commonwealth of Massachusetts. He also served in World War II and was commissioned as a Major in the U.S. Army when he was discharged. His interests were mostly in sports and Legion activities. He was not married.

A note from **John G. Sullivan** of Pleasantville, N.Y. reads, "My wife Ann, to whom I was married in June 1936 died suddenly in 1969. Subsequently, I have had the great good fortune to remarry—to Mrs. Douglas H. Lawrence on last July 31. We are both looking forward to living in our new home in East Dennis on the Cape when I retire next Spring." . . . **Salvadore Madero, Jr.** of Mexico, writes, "for the past 30 years, I have been in the Pump Business (President of Johnston-Howe de Mexico—which was sold to I.T.T.) Presently, I am chairman of the board of Super Diesel S.A., and also

elected last October as chief executive officer. We manufacture automotive parts for tracks and busses. I am also president of a real estate company in Acapulco—where we own and rent a group of bungalows. I am also chairman of the board of Celulosa del Bajio, manufacturing pulp for the paper industry from wheat stalks. I am in good health and at my age, I managed to take a one-year top management course under auspices of Harvard and Barcelona Universities. I was one of six M.I.T. alumni who took the course. I always look forward to seeing other M.I.T. friends at our Annual M.I.T. Mexican Fiestas."

Alfred N. Lawrence of Lawrence, N.Y., writes, "This contribution to the Alumni Fund is not much, but hope that it will help to keep up the percentages. I retired three years ago and have never been so busy working around the house. I have become as a Mr. 'Fixit' for everyone around here." . . . A note from **William F. Jenkins** of Houston, Texas, reads, "After more than 42 years of service with the Houston Lighting and Power Co. (my only job since I left M.I.T.) I have now retired. I was assistant to the vice president and my principal duties were purchasing and stores at the time of my retirement. I am now pursuing my main hobby full-tilt, that of raising trees from seeds for use in arboretums. I try to raise all the native trees. My arboretum now contains about 125 species, but when I get through developing a new 20-acre-tract, I hope to have over 200 kinds of trees—I'll be busy."

Theodore S. Alexieff, of London, England writes, "What is new with me? I am looking forward to and planning my retirement—winding up a career with an American outfit (F.M. Insurance Co. Ltd.) in an International operation which has had many rewarding challenges. Apart from me, I think you have done a fine job in encouraging newer flow of news from our classmates."

Eugene H. Gilman, Mountainside, N.J., writes, that he has just moved to Wilton Manors, Fla., and is in the process of getting settled. He has one son in pre-med and the youngest daughter graduating from college. He has been retired for two years and still trying to get used to it. He and his wife Ruth have five children and six grandchildren. . . . **L. Malcolm Mosher** of Weymouth, Mass., has sent a note which reads, "As of May 1, 1971 I retired from the Quincy Shipyards, division of general dynamics. My wife Margaret and I look forward with pleasure to a life of leisure. We hope to do some traveling, play some golf, do a little fishing and in general, enjoy doing things that we normally don't have time to do while working."

Hazen E. House, Knoxville, Tenn., retired from Alcoa as assistant chief electrical engineer on January 1, 1970. He has served as chairman of various committees for professional societies such as I.E.E.E. and N.A.M. He is a life member of I.E.E.E. and a member of A.S.M.E. Hazen was elected an I.E.E.E. Fellow on January 1, 1971 "for contributions to the determination of electrical and thermal characteristics of stranded and bare conductors." His hobbies include fishing, photography, ship and metal work. . . . A note comes from **Amasa G. Smith,** Birmingham, Ala., that he retired from Chicago Bridge and Iron Co., on October 31, 1971 after a long distinguished service. He began working for the firm in July 1929 serving as shop superintendent, then in 1947 became plant manager, in 1961 manager of southeastern operations, in 1964 vice president, in 1965 a member of the board of directors and from January 1970 until retirement was area manager. Mace has been very active in many community activities in the Birmingham area, among them: Rotary Club, Board of Directors of the Associated Industries of Alabama, the Executive Committee of the Birmingham Area Council Boy Scouts of America. He received the B.S.A. Silver Beaver Award in January 1958 and was chosen "Man of the Year" for Birmingham in 1959. Mace attended our 40th Reunion with his wife Sara and daughter.—

Lawrence R. Moses of Sarasota, Fla., writes, "Retired to above address 18 months ago. We built a new home in Village Green on an executive-type golf course with a swimming pool attached. Thoroughly enjoying community, golf, swimming and other social activities, I do volunteer study work at the hospital Tuesdays, and am attending boating and piloting classes Thursdays conducted by the Power Squadron. I often meet other M.I.T. men at our local alumni club. Our three children and two grandchildren are living in widely separated areas. Our health and attitudes are excellent."

Carl Howard of Lexington, Mass., writes, "How pleasant to receive your note! Apparently you have been in touch with Robert Pride recently. I certainly would like to see him and you too. I have seen Andy (Charles Anderson '30) several times this year; in fact our friendship has been uninterrupted since our high school days. Thank you for your personal touch." . . . **Nerses Der Marderosian** of Needham, Mass., has been running a family-owned firm dealing in oriental rugs since graduation. A year ago, he suffered a heart attack from which he has recovered. He is now in semi-retirement. He has four children and six grandchildren. . . . **Donald L. Hibbard** of Moylan, Pa., who is president of Board of Pensions (Presbyterian Church) writes, "I feel more optimistic about M.I.T. and U.S. Society in general than I have for a long time. It is good to be living in these days with all its challenges and opportunities. Self-imposed retirement is coming at the end of 1972, and I am looking forward to doing some other things for humanity."—**Karnig S. Dinjian,** Secretary, Apt. 14-E, Starlight Towers, 6000 N. Ocean Blvd., Fort Lauderdale, Fla. 33308

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Notices of the retirement of our classmates continue to roll in. The most recent notice concerns **Ralph Peters'** retirement from Eastman Kodak as of the first of this year. Ralph went to work for Kodak in 1931 after he had received his M.S. degree, and at the time of his retirement he was assistant superintendent of Kodak's paper mills division. He was a director of T.A.P.P.I. and active in T.A.P.P.I. committee work for many years. The notice I have doesn't say what his retirement plans are. . . . **Parker Starratt,** our first class secretary, retired from Bethlehem Steel Co. as of January 31, 1972. He plans to sell his house in Bethlehem and move to southern New Hampshire. He promises to send further details when his plans have crystallized. . . . **Alwin Newton** retired from Borg-Warner on March 1, 1972. He expects to do some consulting work for Borg-Warner for a year or so, but will shift his activity to environmental improvement. He says that he is "chairman of many local activities in solid, liquid and air pollution control and have been for many years. Now it is respectable!"

R. W. Peters, '30

Dick Foster has retired from Campbell Soup Co. and has moved from his home in Haddon Heights, N.J. to Cape Cod (see new address below). Presumably he will now have more time to pursue his hobby, which is refinishing antique furniture. The Fosters have a son Donald who works for American Hospital Supply Co. and a daughter Susan who is supervisor of N.E. Medical Center in Boston. . . . **Bob Foster** is a consulting engineer (building construction) doing business as Robert A. Foster Engineering Corp. in Concord, N.H. He is treasurer of Merrimack County, trustee of Concord Hospital and chairman of its building committee which is currently supervising a 5.5 million dollar addition job, chairman of the city building code board of appeals and a past president of the Concord Rotary Club. Bob's first wife died in 1966 and he has since remarried. He says that he and his wife visit back and forth occasionally with the **Harold Spaans** who live in Wayne, Pa.

Jack Bennett reports that he is "enjoying retirement no end." He has returned from a trip around the Pacific with stops at Hawaii, Tahiti, Australia, Bali, Singapore, Sumatra, Java, Hong Kong and Japan. The Bennetts are planning to spend the winter at their home on the north end of Captiva Island opposite Ft. Myers, Fla. Jack said that they would be pleased to see any Florida travellers from the Class of '30. . . . **Jay** (Cappy) **Ricks** is president of the Thomasville, N.C. Board of Realtors for 1972. He is active in Rotary Club, church and civic affairs.

Gerry Morse, whose many extra-curricular activities were given in the July 1968 Notes, has taken on a few more. He is a

director of the Minnesota Hospital Service Association (Blue Cross), Twin City Hospital Association, Metropolitan Medical Center and Minnesota Safety Council, as well as a member of the Minnesota Manpower Services Advisory Council, Board of Human Rights and Senate Compensation Committee. . . . The Reverend **Vincent Thormin** reports that he is semi-retired. Vince says that there is a shortage of United Church Ministers in the Kingsbury, Quebec area where he and his wife live, and that in the short time he has lived there his services have been required more than he had anticipated. . . . In mid-December 1970 **John Pratt** had a heart attack and heart operation which was followed by a series of other health problems that kept him in the hospital most of the time for a period of about four months. However, he indicates that he is gradually getting back to normal and is now able to drive a car again.

We have received a notice that **Ciro Martinelli** died at his home in Princeton, N.J., on November 21, 1971. Ciro had worked for Radio Corp. of America since graduation and had retired in June 1971 as senior engineer in charge of tracking stations. He and his son John were members of the engineering team that designed the Tiros I and Tiros II weather forecasting satellites. His wife Josephine died in 1969. He is survived by his son John and three grandchildren.

Changes of address: Henry N. Bates, 5691 Southmoor Lane, Englewood, Colo. 80110; Emanuel I. Birnbaum, 6700 Gulf of Mexico Dr., Sarasota, Fla. 33577; Richard G. Foster, Horizon Dr., Chatham, Mass. 02633—**Gordon K. Lister,** Secretary, 530 Fifth Ave., N.Y., N.Y. 10036

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Our 40th Reunion is shaping up. It is not too late to make your plans in case you did not reply to the mailing which you received in February. Just send a note to **Don Whiston,** Room E18-260, M.I.T., and he will add your name to the evergrowing list of classmates who plan to attend. Your Reunion Committee met on February 15 and is working towards a good program for you. Plan to stay on for Alumni Day activities. **Bob Semple** and his 40th Reunion Gift Committee are working hard to reach our goal of a $500,000 gift. If you have not yet contributed or if you could increase your gift it will help achieve this goal.

Arthur L. MacKusick and his wife Bettie write that they are planning to come to the 40th reunion in June from their home in Merritt Island, Fla. . . . **Henry E. Worcester** hopes to get to the reunion. He is living in Annapolis, Md., and is still in the dry cleaning and laundry business and also still keeping his race horses. . . . **Roger J. Zampell** has moved back to Alexandria, Va., from Ft. Lauderdale, Fla., for one year and expects to return to Florida before next winter. . . . **Earl F. Anderton** has moved from Zurich, Switzerland, to Scott Paper Co.'s staff headquarters in Belgium where he has a new job as Director of Logistics—European Operations.

Frank Cook has returned to Tustin, Calif., from an extended business and pleasure trip in Mexico. He and his wife plan to return after February, hoping to have a new assignment by then, but if not will spend their time looking for an outstanding semi-retirement area. . . . **Frank S. Chaplin** is still doing consulting engineering on product development in the Philadelphia and Harrisburg areas. With their four children now through college, he and his wife are starting to enjoy themselves. They visited London and the south of Spain in September. Frank is an enthusiastic skier and last season added touring to his downhill skiing.

Raymond K. Flege will retire in June, 1972, from his professorship at Georgia Institute of Technology. He will continue to live in Atlanta. . . . **Mrs. O. Mason Burrows** is Supervisor of Social Services in the Welfare Service Office in Marlboro, Mass. Sam Burrows, Class of '31, is with the Norton Co. in Worcester, Mass., working on refractory cements; his two sons also live in the area. . . . **Ira J. Bach** is president of Urban Associates of Chicago, a consulting firm on housing and planning as well as a developer of large-scale residential developments. Ira is author of a book published in 1969 with the title *Chicago on Foot—A Series of Architectural Walks.*—**Elwood W. Schafer,** Class Secretary, M.I.T. Rm. 13-2145; **James Harper,** Assistant Secretary, 2700 So. Grant St., Arlington, Va.

33

The Alumni news story for 1933 looks a little better probably because one issue has been left out. Perhaps if they left them all out but one, I might be able to assemble enough news for a full page. Leona and I appreciate getting all the Christmas cards and messages even though we just can't reply to all. So, our thanks and greetings to those thoughtful folks.

We have a card from **Cy Hapgood,** who admits that he is getting his three squares and (probably) as many martinis. He announces the impending appearance of a third grandchild. Cy states unofficially that he is in semi-retirement, but still keeps a finger on the pulse of the patent business, "enough to point out partners' mistakes, and show them a few tricks not already learned." Many thanks, Cy. . . . Another full card is from our own Dorothy (Mrs. **Gerard**) **Kincade.** Two of the boys and two grandchildren spent the holidays with these fine grandparents. Gerry saw daughter Susan win the diving championship at Lincoln, Neb. I do hope that more '33 wives will write ye scribe.

Two of our better '33 mechanicals have been honored since our last issue. **Clarence Farr,** first, on his retirement from Mitre, where he has been most recently corporate historian. He has been best known as the focal point of all technical papers at Mitre. At a large meeting of associates, he was presented with a pair of tape recorders, a cash gift, and a caricature signed by every one of the 125 friends who attended the meeting. Clare and Aline have recently sold their 200-year-old house in Reed's Ferry, N.H., and have moved to a smaller home in Nashua more suited to two elderly folks, Clare especially. He says that this move has cut maintenance by 200 years. I hope that they will accept our best and most sincere wishes on this memorable occasion. . . . The second mechanical honored is **Horace S. Beattie,** who has received a coveted award, at the annual meeting of the A.S.M.E. in Washington, D.C. This medal, established in 1920, is awarded for eminently distinguished engineering achievement. The citation says: "for the many outstanding contributions to the design of business machines, through his numerous ingenious inventions, and through his leadership." Horace has been with I.B.M. since his graduation, progressing from trainee to his present position as vice president and director of engineering. Horace is also a member of the I.E.E.E. and S.M.E. Please accept the sincere congratulations of all your classmates.

Cal Mohr comes through again, in connection with his business and personal travels. He visited Rochester, N.Y., in time to attend the 25th annual meeting of the Rochester section of the A.I.Ch.E., and discovered **Walt Swanton's** picture in the group of past chairmen of the section. Walt was chairman in 1964. . . . **Bill Huston** and his lovely Dorothy called on us in Florida, a month or so ago and they chose the right time, 4-6 p.m., since we always have refreshments of all kinds for young and old, and some of them make us feel a little younger. We enjoyed the Hustons' visit immensely. They were about to leave on a short cruise at the time.

I must retract a snide crack in the January issue, about fellas that won't get any more publicity because they don't write ye scribe. That one referred to **John Wiley.** Now the retraction is surely in order as John retired from his position as port aviation director of New York, on February 1, 1972. Upon his retirement he was presented with the Silver Medal Award of the F.A.A.; the citation reads, "Awarded for distinguished service to John R. Wiley, for his ability, dedication and foresight over 20 years as Director of Aviation of the Port of New York Authority, in the development of the New York Airports to meet the spectacular growth of air travel and who deserves the gratitude of the entire aviation industry and community." John joined the Port Authority in 1950 as deputy director of aviation and became director in 1955. John, at 60, is not one to retire; he will be with M.I.T. and will be engaged in teaching and research in the Flight Transportation Laboratory. He will also be associated with the International Civil Aviation Safety Center in Beirut, Lebanon, funded by the United Nations, where he will prepare and teach a course of study on airport operations for government officials and airline personnel from developing nations. *(See p. 82, this issue.)*

We have two of our usual Christmas letters this year. First from Germain and **Jack Andrews** who are still the very busy pair. To the Caribbean earlier, they flew to St. Vincent and boarded a chartered yacht and visited this fabulous island.

Their four grown children are all busy but Germain is the most active Andrews: she teaches, got in a week's skiing in Vermont, and is chairman of the Princeton Skating Club's professional committee. Jack, last but can't be least, is still with the State of New Jersey Department of Transportation, but has outgrown maintenance and is now with the planning division.

Red (**Charles** to you) **Payne** and his Marcia come through with a similar report. Last spring Red and Marcia flew to Cyprus, then on to Istanbul and other places in the Near East, doing a bit of diplomatic work and some archeological research. On the return trip, they visited son Duncan in Rouen, then visited the three sister cities of Rochester, N.Y., all in France. Finally, Red went on a great fishing trip to New Brunswick, where he fished for salmon and grilse (young salmon). We look forward to Marcia and Red's annual letter and appreciate the work that goes into it.

We have a remarkable story about **Athelstan Spilhaus,** who had a degree from his native South Africa when he came with us to take a master's in aeronautical engineering. This article occupies six pages in the *Smithsonian* magazine and I suggest that if you have any interest in the many activities of this remarkable man, write me and I will Xerox the article for distribution; or, you may write the Smithsonian Institution for a reprint.

We have a few address changes: Mrs. Leonard Bradford, Morris Guralnick, John E. Logan, Mrs. Edwin H. Macewan, Lewis W. Morre, and Edward P. Oxnard; these are available to those who follow the usual, expected procedure. . . . Don't forget to make your plans for the reunion in June of '72. . . . Now, fellas, and gals, Leona and I are not exactly lonesome, but we do love to have classmates drop in. Won't you keep us in mind? We are here until mid-May, then it's Exeter, N.H. Best to y'all.—**Warren J. Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

34

For a pleasant change I have really more material than should be used for a single month's notes. So if your Alumni Fund note does not appear below, it will next month—they are all greatly appreciated.

Back before Christmas I had a nice letter from **Jim Eder.** After some remarks about the problems of class secretaries Jim got a little more personal. "My parents died these past 12 months and I am sort of at loose ends. I have been doing a bit of development work, and have finally made a workable production sport airboat. I had attempted to make a hovercraft, but stopped that as it was too costly a development project. No one makes good propellors or fans for a two-man hovercraft. I developed a pusher prop for the airboat out of sheer good luck and necessity. How to produce it in quantity is the problem. I'm trying to make it out of fiberglass after attending a course at M.I.T. under Fred McGarry. Am hoping someone will come up with a manufacturing business for sale where I can become active again. Any suggestion? I'd like something with a real profit so part could go regularly to M.I.T. Meanwhile, I have an apartment and a daughter in Cali, Columbia where I have started an automobile radiator factory with a former excellent employee. Thus it is Christmas in Cali for our family. Best wishes." Jim had included a snapshot of his airboat—very neat, about eight feet long.

Late in December I had a note from **John Hrones** with a clipping that carried the sad news that **Sam Joroff** had passed away on December 7, 1971. Sam took undergraduate work in Course XVII and went on to receive a master's in city planning. In 1961-62 he was a special planning consultant to Turkey and he had also done consulting work for the United Nations. At the time of his death he held the position of deputy director of the Office of Staten Island Development, a unit of the office of the Mayor of New York. On behalf of his classmates I would express our condolences to Mrs. Joroff and his son Jan. . . . Unfortunately I have one other loss to note. The information came to me too late for inclusion in the February Class Notes but that issue did carry the passing of **Angus McCallum** on November 30, 1971. I am sorry that we are so late in expressing our sympathy to Mrs. McCallum.

That same issue also carried a one-line announcement of the National Association of Purchasing Management Award for outstanding service to **Phil Kron.** What it didn't say was that the award was made on November 30 and that on the next day, after 31 years of service with Eastman Kodak, Phil retired. So welcome to the club, Phil. The 1971 "Rimbach Review" is a truly monumental account of the year for Sylvia and **Ted Rimbach** and their family; he added, "It's been a busy year and more to come in the pollution control effort. Many impatient, some moving too slowly, but many working positively and not getting much notice."

A much delayed clipping tells that last August **John F. Campello** was appointed assistant to the chief engineer in the nuclear division of Stone and Webster. John has been with them since 1941. . . . When the son follows in his father's footsteps, there are occasional serendipitous side effects. K. Winston Gardner '68 must have sympathy for class secretaries, for he was kind enough to send me a clipping from the *North American Rockwell News* that reported the election of his father, **Karl A. Gardner,** to the grade of Fellow of the A.S.M.E. Karl has devoted his career to heat transfer and process equipment design and has gained a position of eminence in this field. He has been with the Atomics International Division of N.A.R. since 1968 as technical advisor to the division director. Prior to joining A.I., he served in important consulting and engineering teaching posts. The Gardners are a real M.I.T. family as Karl's father, Albert, is a member of the Class of 1911.

Now for a few of the Alumni Fund notes. One is rather baffling and I prefer not to identify. He says, "No activities to be recorded until your activists are 'fired' or executed." I don't quite understand why class notes should suffer because of his concern over some of the happenings at M.I.T. (unless I'm one of his "activists.") but since this note presumably accompanied a contribution to the Alumni Fund, the writer should be applauded for his willingness to continue support even though he may dislike the actions of some of the staff or students. . . . Another cryptic note comes from **William Schumacher,** "Still recovering from third-degree burns of both feet, which hospitalized me for three months." We're very sorry to hear that Bill has been involved in what was apparently a serious accident. But, good Lord, why so brief?

In a more conventional vein, **Harold C. Leighton** writes, "I am general superintendent of the Beckett Paper Co. and have been working with them in Hamilton, Ohio for 34 years (with four years of W.W. II service).

George Bull writes he retired at the end of November, after 20 years of federal civilian service and in January he and Mary Elizabeth started on travels that are to last to mid-May. My letter came from Tokyo and George promises to try to write a letter a month until he gets back. So with luck we can run a soap opera for a while. Next month—Hawaii, Japan, and who knows what!—**Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631

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When a '35er takes on the job of Class Secretary, he really enters show business! Come what may, the Notes get written! Your Secretary, at this writing by his wife Doreen, is in the hospital, recovering from a coronary on February 5. Just as one can't be a "little bit pregnant," one can't have a mild coronary, but the damage was not extensive, and happily his recovery is progressing at a great rate. By the time you read this, he will be home and probably at his wit's end to fill the days 'til he can return to the office.

Now is the time to take pen in hand, put wife in front of typewriter, or (if you're the old-fashioned type) take secretary on lap, and whip-off a newsy letter of your activities to above-mentioned Secretary. The hours he can spend editing those letters will certainly pass the time for him, and think what's in store for you, reading all those notes in future issues! So give five minutes to a worthy cause—keep my husband entertained for a few hours so I can get the laundry done!—**Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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In late January **Hal Miller** entertained class members and their wives at the Tarrytown Hilton. The group worked with Marty Phillips of the Alumni Fund Office to lay plans for our 40th Reunion class gift. Unfortunately several of us from Boston were unable to attend but Con-

D. Devereux, '36

necticut and other areas of metropolitan New York were well represented. Present were: Eli and Vivienne Grossman, Py and Mary Williams, Ariel and Avis Thomas, Charlie and Priscilla Holman, Dana and Harriet Devereux, Pat (J. F.) and Marian Patterson, Mal and Florence Graves, Fred and Mary Assmann, Henry and Mildred McGrath and President Tony and Marian Hittl. Our thanks to Hal Miller for helping our efforts get off to such a good start. Needless to say you will be hearing more.

Congratulations are due to **Dana Devereux** who has been elected president of the Emerson Consultants, Inc. Dana has been with Emerson, a 72-year-old management consulting firm since 1941. . . . In the last issue of the *Review* there was an article by **Boynton Beckwith.** He has also appeared in print in the *Bulletin of the American Meteorological Society* on "The Effect of Weather on the Operations and Economics of Air Transport Today." . . . With his contribution to the alumni Fund **Larry Kanters** writes; "Now that the four chicks have flown the coop there's lots of room for any 36-ers who may wander this way (Minneapolis)—seasonal skiing or sailing plus year 'round billiards 'n bullin."

The last issue of the *Review* carried the notice of the death of **Alfred Lawson.** I have no details. . . . Classmates continue the southern move.—**Delwin Campbell** is now in Dunedin, Fla. (2054 Heidelberg 33528). Rather east than south is the move of **Charles Austin** to 10264 Twin Oaks Dr., Sun City, Ariz. 85351 although he did detour through Florida on his way from Marin County.

You will be hearing much more about class activities as we look toward our 40th reunion. Plans are under way for smaller get-togethers at scattered points. If you have suggestions for locations or are willing to help, do let President Tony know (or me!)—**Alice H. Kimball,** Secretary, 100 Memorial Dr., Apt. 8-6C, Cambridge, Mass. 02142 or Box 28, West Hartland, Conn. 06091

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Your class reunion committee has been active and all of the Class have been mailed the details of our 35th Reunion at the Chatham Bars Inn on Cape Cod, June 2 through 5, 1972. As of the end of January and before the mailing, the following members of our Class had already indicated that they were planning to attend: Phil Peters, Joe Heal, Ralph Webster, Len Seder, Bob Thorson, Norm Birch, Mort Nickerson, Bob Goldsmith, Charlie Antoni, Ed Hobson, Al Woll, Milt Lief and Walt Wojtczak. If you have not sent in your registration form, you still have time to get it to **Joe Heal,** 39 Tower Rd., Hingham, Mass. 02043. A questionnaire on facts about our Class has also been sent out and we request all members to answer the questions and mail it to **Len Seder,** 267 Hawthorne St., Malden, Mass. 02148. Chatham Bars Inn offers everything you could desire, plus an opportunity for you and your wife to visit with old friends. Hope we will see you there.

Les Klashman was recently presented a special Distinguished Service Award by the Environmental Protection Agency in Washington, D.C. He was honored for his exceptional services during his long period of employment with E.P.A. and predecessor agencies culminating in his present post as deputy regional administrator in the northeastern states with offices in Boston. Les is also a recipient of the Department of Interior's Distinguished Service Award.

Walt Black sold out his ownership in Brabender Instruments and retired for six months. He then started a new instrument business, "Haake Instruments", in Saddle Brook, N.J., on August 1, 1971. Walt plans to get it underway and to semi-retire on December 31, 1972.

Charles E. Reed has been named a senior vice president of the General Electric Company with responsibility for technical resources of the company. . . . **Phil Peters** reports that he met **Paul W. Allen** while on a recent trip to Japan for John Hancock. . . . **Francis D. Houghton** is the state pesticide surveillance scientist for New Hampshire and has recently been appointed chief of laboratories for the New Hampshire Water Supply and Pollution Control Commission. . . . **John Jacobs** lives in N. Beach, San Francisco and at Tahoe. He is in systems planning at Bechtil; management information systems, process simulation and reactor design. John states he has about 11 hobbies and averages 100 days per year skiing and also runs long distance, competitively, plus lots of back-packing.

It is with regret that I report the death of **H. Dudley Swain,** on September 8, 1971. Dudley was the president of the Industrial Lofting and Manufacturing Company of Bridgeport, Conn.—**Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Curtiss Powell,** Assistant Secretary, Room 5-325, M.I.T., Cambridge, Mass. 02142; **Jerome Salny,** Assistant Secretary, Egbert Hill, Morristown, N.J.

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Several Sundays ago, with spring on the wing, your Secretary and bride were driving in south Jersey. We shunpiked, hitting roads we had never heard of, until we came to Fairmount Ave., Chatham, which gave us the excuse to stop in and visit with Jean and **Ed Hadley.** After several drinks, the subject of 38-35-73 came up. Bob Johnson, if you are listening, Ed and I vote for the Bald Peak Colony Club for that 35th reunion in 1973.

With women's lib around, I am almost afraid to bring up the next item—the class has two new Fellows, which raises the question can a gal become a Fellow? **Mead Bradner** was promoted to the grade of Fellow of the American Society of Mechanical Engineers at the winter meeting of the Society. Mead is Director of Research and Coordinator of Engineering for the Foxboro Corp. . . . **Bruce Old** a senior vice president of Arthur D. Little, Inc., was elected a Fellow of the American Society for Metals in recognition of his distinguished contributions in the field of metals and materials. Bruce has been responsible for some novel developments in iron and steel manufacture, employment of radio-active tracers, and engineering applications of atomic energy. . . . **Yale Brozen,** currently professor of economics and director of the applied economics program in the graduate school of business at the University of Chicago, has just been named an Adjunct Scholar in Evaluation Research at the American Enterprise Institute for Public Policy Research in Washington. . . . Last item this month is a note from **Dave Baker:** "Am still continuing my business activities as President of Hugh J. Baker and Co. in Indianapolis. In addition have had an interesting year working with Indianapolis Settlements, Inc. as vice-president and with the National Council on Crime and Delinquency as a member of Board of Trustees".

Mark down M.I.T. Homecoming this June in your little black book—maybe I'll see you there—**A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, Penney and Co., 140 Broadway, New York, N. Y. 10005

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Several capsule items: **Arthur A. Schiller** was re-elected for his third term as mayor of the village of Plandome Manor, N.Y. . . . Dr. **Mac L. Keith** is professor of geochemistry at Penn State College, Penn. . . . In a similar field is **Kenneth L. Cook,** professor of geophysics at the University of Utah, in Salt Lake City. Ken and Lois travelled in U.S.S.R. for a month in 1971 to attend meetings of the International Union of Geodesy and Geophysics, in Moscow, and also visited Novosibirsk, Leningrad, and Kiev. . . . Another '39 traveler to Russia was **Thomas J. Reading,** on a trip arranged by the American Concrete Institute. He wrote that he was especially impressed by the mass production of pre-cast housing elements. . . . **Wiley Corl** returned home from emergency surgery, for extended convalescence with further operations likely. . . . **A. Lindsay Thomson** has been elected chairman and chief executive officer also, of his company, Terry Corp., of Windsor, Conn.

Theodore P. Snow died December 15 at the Huntsville Medical Center, in Alabama. Ted began at Boeing upon graduation and served continuously there until his death. He was the Boeing Representative to N.A.S.A., Huntsville.—**Oswald Stewart,** Secretary, 3395 Green Meadow Circle, Bethlehem, Penn. 18017

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This is the April Fool issue, *Tech Review* having skipped its appearance in the last issue. . . . From **Worden Waring**'s Xmas card comes the note that he is now with the biomedical department of the University of California at Davis. . . . **Marsh Bearce** questions his typing ability, but his letter is most welcome: "I doubt that anyone has been as avid a reader of class notes as I—nor as bad a reporter—but an incident this summer is too good not to share. The Chicago M.I.T. club published an area directory this year. This resulted in a number of phone calls ending up with Peggy and **Bill Kather** hosting a delightful cocktail party in their high-rise apartment on Chicago's north side. Present with their wives were Hal Davis, Ed Fettes, John McKee and I. It was a great gathering with much reminiscing. Bill Kather has his own consulting business in chemically oriented matters of production, marketing, etc. **John McKee** is a research Metallurgist at Argonne National Labs. **Hal Davis** has his own manufacturer's rep business with his principal accounts in mechanical products. Dr. **Ed Fettes** is polymer technical director for Northern Petrochemical Co., and I'm a sales engineer for Messinger Bearings, Inc. I've spent most of my alumni years in the anti-friction bearing business; and the last ten years in the Chicago area. Nancy and I have two adult children both living at home; but I'll be 'father of the bride' next year. Next year I will be president of the Park Ridge Lions Club. I'm a M.I.T. educational counselor for the Maine Township High Schools."

Tyler Marcy is now president-elect of the Instrument Society of America. He is on the corporate staff of I.B.M. as director of technology within the staff for engineering programming and technology. . . . **Amos Shaler** has spent 15 months as special consultant to the assistant secretary general for scientific affairs, N.A.T.O., Brussels, Belgium, where he had the fascinating task of helping to get N.A.T.O. moving in the area of marine pollution. . . . **Joe Libsch,** Vice President for research at Lehigh University has been elected a Fellow of the American Society for Metals. Joe's fields of specialization are kinetics of solid state reactions, high frequency induction heating and selection of materials and processes. . . . **Dick Falls** writes: "My wife, Marjorie (Hamilton), Simmons College '40, has been teaching first grade for the past seven years. This year she is full-time special teacher in learning disabilities in N. Brookfield and has started her master's program in this field at Westfield State College at night. Our only grandson is now 3½ years old. Our second son is a first Lieutenant with the Adjutant General Corps (A.P.O.) at Wurzburg, Germany. Fourth son Peter is a freshman at University of Massachusetts. Youngest son Robert and only daughter Janet still in Jr. and Sr. high school.

Gordon Livingstone is now an airline operations engineer working on the Lockheed L-1011 Tristar at Palmdale, Calif. . . . Stewart Miller has received the Morris N. Liebmann Award of the Institute of Electrical and Electronic Engineers for pioneering research in guided millimeter wave and optical transmission systems. Stewart is director of guided wave research at Bell Laboratories. . . . **I. M. Pei** received a Washington Board of Trade award for excellence in architecture for the Third Church of Christ, Scientist and Christian Science Monitor Building completed in 1971. **Dave Hoisington** writes: "Recently stopped at San Diego Yacht Club and was pleased and surprised to run into Jack Wood, retired sailing master. He is as active and enthusiastic as ever, and very happy to be running a junior sailing program."

Norm Laschever is still with R.C.A. in Burlington, Mass., but has moved from Sharon to Lexington. . . . **Bill Merrill, Jr.,** remains with Lockheed Calif., on the L-1011 Tristar project. He is involved with thermal and pneumatic analysis such as air-conditioning, aircraft ice protection and a host of thermal problems. . . . It is nice to hear from **Hans Otto** after many years; he advises that Liz and Charles are married and both couples have the "girls" working as registered nurses while the husbands do graduate work. Richard, their youngest, is a senior trying to decide which college to go to. Hans and family have lived in Manhasset over 30 years, commuting on the L.I.R.R. . . . **John Halford, Jr.,** last July was elected secretary of the Hebron Academy Board of Trustees and was also elected as president of Southern Worsted Mills, Inc. He has managed to stay in Boston by holding onto the title of Treasurer also. Due to a stroke, he has given up his duties on M.I.T. alumni council on behalf of the G.M. group. . . . **Ed Bromberg** announces the marriage of his son John to Susan Harkness of Middlesex, N.J., on August 21, 1971. Son is a graduate of Columbia College where he was president of Eastern Intercollegiate Bridge League and now is a candidate for a doctorate of Juris Prudence at the University of Texas School of Law.

The last piece of news is from **Lester Lees,** "In a weak moment I agreed to become director of our new Environmental Quality Lab at Cal Tech, and we have been busy finding out how complex are large-scale environmental problems. We are tackling air pollution in L.A., energy and the environment, especially electrical energy, and water, including recycling and reclamation. Lots of fun!" . . . In days gone by, *VooDoo* noted "the jokes we print you don't like, the jokes you like we can't print." That isn't true for news in this column. The news you furnish we print. Write—**Al Guttag,** Secretary, Cushman, Darby and Cushman, 1801 K Street, N.W., Washington, D.C. 20006

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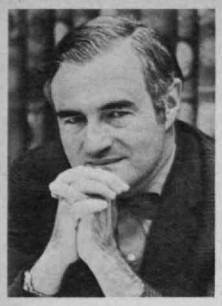
"Nothing ever happens in Nantucket in the winter," is the gospel-cliche of the Island, which has certainly not been true for your Class Secretary. Moving my office across the street to 22 Broad, through ice and snow and capricious winds blowing papers up and down the length of the block, became as complicated as the Normandy Invasion, and I am only now beginning to find files and letters. My secretary has agreed to remain with me only if I sign a 59-year lease on my present quarters; so if you are on-Island this summer you will find me at the new digs.

A cheerful note from **Luke Hayden** who has recovered completely from his last fall illness, showed him to be on the job at City Savings Bank in Pittsfield, Mass., with no sign of any physical problem at all. Nice to know you are back in harness, Luke. . . . A news release from the *New York Times* showed **Carl Mueller** being promoted at Loeb, Rhoades investment banking house, where he has been named a joint managing partner with John L. Loeb, Jr. Our congratulations to Carl on this giant step and our best wishes for his success. . . . CalTech's engineering and science magazine contained a fascinating article about **Robert L. Sinsheimer,** "A Concerned Biologist." The concluding lines of a talk "The End of the Beginning," read, "We in science are growing up now. Our toys become more potent. The little games we play with nature are for great stakes, and their outcome moves the whole social structure. We must accept our responsibility." Wise words for the CalTech people, and wise words for all of us who share his Class at M.I.T. His career continues to be an inspiration to all interested in sci-



R. Sinsheimer, '41 *J. P. Longwell, '43*

entific pioneering.

A brief report this month from your erstwhile Secretary, but I have to get back to looking for one of my files. I should be well-settled by the next issue, and will look forward to hearing from you in the interim.—**Michael Driscoll,** Secretary, Box 1044, Nantucket, Mass. 02554

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More Thirtieth Reunion News: (as of February 1) the committee has received about 85 favorable replies to the first announcement. Plans are nearly complete and if we can get approximately 30 more firm reservations, we can have exclusive use of the Wychmere Club for our weekend of June 2 through June 4. So if you haven't gotten your class dues and reservations in yet, please send them to: **Warne Johnson,** 15 Princeton Place, Upper Montclair, N.J. 07043. The tab is only $50 per person for the whole weekend. This is going to be our best reunion ever! Don't miss out. Will be looking forward to seeing you in June.

Also, International Buffet and M.I.T. night at the Boston Pops is on Sunday evening, June 4. Dorm space will be available to us as a reunion class that night. If the response is good, we'll try to get a block of rooms in one dorm location for the Class.

With wry humor, **Neil Cogan** reports that ". . . after 11 romantic years with I.C.B.M.'s, am now enjoying the rich fulfillment of all my experiences as senior engineer with Travelers Insurance Company in the field of product liability." . . . For the past five years, **Bob Davis** has been staff supervisor of reports and publications at U.S. Steel Corporation's Applied Research Laboratory in Monroeville, Penna. . . . **Carl Trexel, Jr.,** is still in the economics division of the S.R.I. Energy and Resources Program at Menlo Park, Calif. . . . **Bob Howard** is always dependable in sending us a complete roster of the Howards which, this year, is as follows: Angelika is working on her Ph.D. in chemistry at Cornell; Laurana got a B.A. in German at the University of Kansas and is now finishing her B.S. in chemistry at the University of Alabama; Bob will enter the University of Alabama in the fall; Jack and Tom are still in high school.

In the congratulations department, **Hank Brightman** has been promoted from executive vice president to president of Aero-Flow Dynamics, Inc. . . . **Bill Rote** recently appointed vice president of the Equipment Engineering Division of Polaroid Corporation. . . . **Hilda Kressman** was elected Mayor of Trenton, Fla. (population 1,000) and took office on January 1, 1972. Though it is not new news anymore, Hilda received the Florida Governor's Conservation Award in October, 1970. . . . **William C. Fortune** (Captain, U.S.N.-Retired) sent a cryptic note that he is promoting his Noumenon Guild, Fortune 8 and other innovator-energizer actions. Would sure appreciate a clue to what's it's all about!

On a sad note, **George Kavanagh** died suddenly the day after Thanksgiving, November 26, 1971. He was a member of the Course Visiting Committee and had devoted most of his professional career to the atomic energy programs of our nation. George originally was engaged in basic research directly related to the Manhattan Project during World War II and he worked for Atomic Energy Commission since 1952. Among many other assignments, George served as a scientific advisor to the A.F.C. Commissioners and was a member of the U.S. Delegation to the 1958 Geneva discussions with the U.S.S.R. and the United Kingdom on the cessation of nuclear weapons tests. Bob Epple of the Class of 1947 gave a tribute to George at the Memorial Services in Washington. We extend the sincere condolences of the Class to George's wife and family.

Again, get your check for Class dues and your Reunion reservation in to Warne Johnson, *now!*—**Ken Rosett,** Class Secretary, 191 Albermarle Rd., White Plains, N.Y. 10605

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Calling all classmates! Watch out for a large lawyer-type Connecticut Yankee heading West with $2,000 of your money! Our varsity secretary, **Dick Feingold,** reports "I am going to move to Santa Barbara, Calif., in June. My remoteness from the geographical location of the Class will dictate that Kelly become the official secretary and that Feingold become the sorcerer's apprentice, so to speak." Dick goes on to say, "I will probably continue as Treasurer and move the class treasury out with me!" A great democracy! Feingold decides that I become secretary and then vamooses with the funds!

Feingold also wrote that he "was at the Alumni Advisory Council monthly dinner in January with **Jim Hoey, Ken Warden** and **Jim McDonough**—the latter is sporting a goatee, Ken Warden left Arthur D. Little after 15 years there and now has his own company. This company is 'Life Management Associates' and the endeavor is motivation consulting and research, either on a company basis or a personal basis. Ken is very happy in this new venture." We wish you all the best, Ken, and please lend a small hand in the motivation of our silent classmates into literary accomplishments.

The Minneapolis Electric Steel Company reports that **A. Donald Moll** has been promoted from vice president, sales manager to president. The company produces cast steel components for manufacturers of heavy equipment as well as alloy steel and iron wear-resistant parts for the taconite and mining companies in the U.S.A. and abroad. How's about a report from you directly, Don? Your last output was a biographical sketch for the 25th reunion booklet! . . . Another release reports that **Charles J. Lawson** has been appointed president and chief executive officer of Rotron Inc., of Woodstock, N.Y. Rotron fans and blowers for industrial applications are used worldwide.

Esso Research reported last autumn that **John P. Longwell** has been named a senior scientific advisor, the highest scientific title the company awards. John joined Esso Research in 1943. At one point in his career he was head of a project team that helped develop the ramjet propulsion system for the U.S. Navy's famed *Talos* ship-to-air missile. A scribble from **Robert B. Marshall:** "transferred by System Development Corp. from Santa Monica, to Integrated Systems Support Inc. (a subsidiary) at Virginia Beach as a department head." So California stays even: Marshall out—Feingold going in! . . . So, there you have it friends: goatees, motivation research, cast steel (whatever happened to cast iron?), blowers and missiles! Interesting—naturally, but it would all sound better if it had more of the personal touch of the nominees! Meanwhile, congratulations to all you fellows and waiting to hear from you—and you!—**Jack Kelly,** Associate Secretary, 34 Scudder Rd., Westfield, N.J. 07090

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After a lapse of several months, the Class of 1944 notes are back in action. Part of the hiatus was due to a lack of notes but the larger share was probably my fault. I switched employers last summer and have been swamped in the new position. (In another issue I'll describe the new challenge.)

First we should acknowledge the fine work performed by some of our classmates in the 1971 Alumni Fund campaign. Our Class Agent is **Norm Sebell,** who deserves much credit for raising our gift total from $17,321 to $40,069. As **John Hull,** our Class President, stated in his October 1971 letter, we should try again this year as a sort of special vote of confidence to the "new" administration. The area chairman for Worcester was **Howard S. Lockwood** and for Providence was **Norman L. Greenman.** The three received Certificates of Appreciation from the Alumni Association. Also noteworthy were the members of our class on the list of attendees at the President's Inauguration: Dr. Sanborn Brown, Lexington, Mass., Joseph F. Donahue of Milton, Mass., Professor Peter Elias, Cambridge, Mass., Mr. Malcolm Kispert, Dover, Mass., Mr. Theodore Nathanson, Boston, Mass., Mr. Alfred Picardi, Washington, D.C., and Mr. Peter Quattrochi, Warwick, R.I. This was the list as of October 5, so if I missed later arrivals, please forgive me.

On a sad note, three of our classmates died last year: **Robert N. Johnson** on June 18, **Phyllis U. Kessel** on October 2, and Lieutenant General **Keith B. McCutcheon** U.S.M.C., on July 18. Phyllis was killed in a British European Airways crash near Aarsele, Belgium. Keith's contributions live on since he was cited in the September 1971 issue of *Ordnance* magazine: he had spent two tours in Vietnam as commander of the Third Marine Amphibious Force.

We received many notes from those of you who sent in contributions to the Alumni Fund. Taking them in roughly alphabetical order: Admiral **Ayres Cunha De Andrade** wrote that he had retired from the Brazilian Navy in 1965 to join his son in private business as president of Spartacus Representacoes, Ltd., in Rio. They represent about five U.S. factories in the fields of electrical installations, telecommunications, and machinery repairs. . . . **Donald Arsem** reported that his children like New England with Nancy having graduated from Colby, Marilyn at B.U., Harold at W.P.I. (Worcester), and Bev still at home. Don and Kay visited "new town" projects in Europe and the U.S. . . . According to the *Harvard Business School Bulletin* for February 1970 (I am late!), **Don Axon** has returned to the Ford Co., as manager of the manufacturing planning office, Industrial and Chemicals Division. . . . *Technology Review* (obviously a better source) for January 1972 reports that **F. Scott Carpenter** has been promoted to vice president of the Cabot Corp.

Bob Copsey is presently engaged in general system engineering and technical direction of the new Navy Fleet Satellite Communication System. I hope he can define systems engineering and analysis better then I can—I finally resorted to the concept that it is a state of mind rather than a series of techniques. . . . **Bill Cooley** is expanding again. He is now president of Housing Systems, Inc. (a supplier of panelized factory-built houses) as well as of Terraspace, Inc. (developer of water cannon equipment for tunneling). . . . It was with pleasure that I read that **John Cooper** has relocated to the Philadelphia area to work for Penn Central "helping to get it back on the track." . . . **Arthur DerShowitz** is still working in planning development at General Electric in New York. Trying to out-guess Phase II, Art? His elder son Daniel was just accepted at M.I.T. Smart boy. . . . **Richard Hinchcliff** reports they sold the family motor service business and he is now with the American Trucking Association. He is a multiple hat man: Director of Traffic, Executive Director of the National Motor Freight Traffic Association, and Secretary of the National Classification Committee. So what do you do in your spare time, Dick?

Stanley Holbrook is on the run also: community affairs, politics, travel, photography, construction projects, and investments. Oh, P.S., he makes his money as technical director of the Converted Plastics Group of the Grace Co. He's been there for 20 years since he left the army (Manhattan Project) and the Oak Ridge/Los Alamos circuit. . . . You may have noted in the October 1971 issue of the *Review* that **Robert Ilfeld** has been appointed associate director for Executive Development Program for the year beginning August 1, 1971. It appears that our class has plenty of executives already developed if Bob needs help. And **John Johnson** wryly noted he was an aerospace survivor—still with T.R.W. systems in Redondo Beach, Calif. . . . **Mal Kispert** has a new position at Tech. He was appointed to the new post of Institute Secretary "to serve as the focal point of an intensified effort to augment the Institute's financial resources from private individuals capable of making important contributions to M.I.T." He reports to the chairman of the Corporation through the vice president.

James T. Lawson has it made. He retired twice (U.S.A.F. in 1957 and I.B.M. in 1962) but is now president of Ultronic Systems Division of General Telephone and Electronics. On the side he enjoys his eight grandchildren, his summer home in New London, and the winter in Naples, Fla. Since there is snow here in Washington tonight, I hope Jim is in Naples. . . . The University of New Mexico announced that Dr. **Francis LeBaron** has been named chairman of the Department of Biochemistry at the New Mexico School of Medicine. Fran has been teaching there since 1964 as an authority on brain and nervous tissue. He was elected the first president of the American Society of Neurochemists and has served on the editorial board of the journal since 1967. Prior to joining U.N.M., he was an associate in biological chemistry at Harvard, where he obtained his Ph.D.

Well, I did get half-way through the alphabet. Next time I will finish and be pleased to add any other information you choose to send in. My new address is—**John G. Barmby,** Assistant Director, Procurement Division, General Accounting Office, Washington, D.C. 20548

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The entire Class, we trust, joins Prexy **Tom McNamara** and yours truly in thanking **Max Ruehrmund** for agreeing to serve the Class and the Alumni Fund as Class Estate Secretary. You classmates, your life insurance agent, and attorney will be hearing from dear old Max all too regularly in the years to come. Include the Institute in your estate and Max will climb off your back!

Isay Stemp, President of Stemp and Co. in New York was a guest speaker at the A.M.A.'s Fundamentals of Finance and Accounting for Non-Financial Executives' Seminar in Manhattan in early March. . . . Fran and I saw **Frank Gallagher** at a distance in "mad"-Boston Garden early in February. . . . **Alan G. Mencher,** Science Attache at the U.S. Embassy in London had a lead paper captioned "On the Local Development of Science" in the December issue *Bulletin of the Atomic Scientists.* I only wish Alan's comments could be printed in their entirety for the paper was certainly food for thought. . . . Rear Admiral **Arthur B. Engel** who retired from the Coast Guard as superintendent of the Academy in New London in July 1970 continues in education as Superintendent, U.S. Merchant Marine Academy, Kings Point, N.Y.

One of the 1971 Presidential Citations went to the San Francisco Educational Council—and would you believe that our own **Vince Butler** serves this council? Vince's Christmas card included the following most amusing note: "Spent a weekend with Lou and **Pete Hickey** last fall. I went swimming on the Jersey shore. Pete spent two hours warning me of the dangerous surf—all of one foot!

We received a most thoughtful note from **Ginny Hildebrand** again thanking the Class for its Memorial Gift in memory of Bob. The August '71 *Bulletin of the American Meteorological Society* had a most detailed obituary of **James E. McDonald.** Following a B.A. from the University of Omaha in 1942, Jim served in the navy as an aerologist, was a meteorology instructor at M.I.T., and reached the rank of Lieutenant-j.g. While instructing at the Institute Jim earned his M.S. with the Class of '45 and in 1951 received a Ph.D. from Iowa State. Jim spent his entire career in the atmospheric sciences.

The family pictures included in Edna **J. J. Strnad**'s Christmas greeting left no doubt as to the differences that exist between our generation and that of our children. J. J. continues to wear his hair, now grey, navy V-12 style while the kids were properly attired in carefree fashion of the next generation. Jeff Strnad is now at Harvard after a year at Stamford —a switch to the conservative? . . . From Rosemary and **Nick Mumford:** "We keep busy and appear to see one another only in passing! I'm gone part of at least two weeks each month—El Paso and Hunts-

ville, Ala. My job is about the same (L.T.V.-Aerospace); working more from the management side, but still technically oriented. Rosemary is very active church-wise."

The names of Mumford and Hickey, of course, brings to mind the name of their roommate—old **T. I. Stephenson.** Christmas '72 found Tom and Jimmie in Davenport, Iowa where Tom serves ALCOA as works manager. . . . The **Charlie Pattersons'** card reported that young Chip was a goalie on his hockey team while Sue's bag was riding during the summer and fall. My son Jonathan corresponds with Chip and I'm told that Chip usually practices sometime before 6:00 a.m. Do you suppose dear old dad is the chauffeur! Chuck's old roommate **George Bickford** and wife Betty reported the "usual", i.e. the saga of high school and college including teaching, if you will, on Betty's part.

We should hasten to add that the likes of Tom and Louise McNamara, Jim and Ella Brayton, Lois Busby, Chick and Helen Marie Street, Chris and Jean Boland, Art and Luna Hall, Dave and Mary Trageser had Holiday thoughts to pass on to your classmates. Fannie and I tried to get Elaine and **Bill Shuman** over from Amherst, N.H., in early February but Elaine would not leave her nest; it seems she was anxiously awaiting a second grandchild. Should today's storm abate we expect Billie and **Al Bowen** to be here overnight.

Ed Stoltz, Jr., has forsaken Princeton, N.J., for Englewood, Colo.; when you consider that Johns Manville, Ed's employer is now headquartered in Denver all the pins fall in place. . . . **George B. Hetrick**'s new Lancaster, Pa., address would suggest that Bud had been transferred to Armstrong Cork headquarters after several years in St. Louis, Mo. . . . In early December **Jerry Patterson** gave us the following rundown on his new Montrose, Pa., home reported in the December *Review*: "We are on top of a hill with a gorgeous 360-degree view; perfect three-stall stable within 100 feet of the house, a two-acre fenced-in corral for our two horses, plus Liz's pony, even a small fenced ring! There are 11 acres in all. Libby is chief groom and stable boy." If the pictures Jerry forwarded are really his he has not exaggerated. . . . The foot of snow outside the window suggests that I not forget **Sherry Ing**'s card and its family picture taken on a beautiful Hawaiian beach. See you in sunny May or June!—**Clinton H. Springer,** P.O. Box 288, New Castle, N.H.

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It is a wintery day as we begin to write these Class Notes for this spring issue of the *Review.* A heavy, wet snow is falling and I am recovering from a trip we just completed with nine cub scouts belonging to my son, Neil's cub pack to the Football Hall of Fame in Canton, Ohio. The visit at the museum was very nice, but we made the trip in our station wagon, the nine boys and I. The trip only takes one hour and fifteen minutes each way, but that is about one hour and five minutes too long to suit the boys. However, we have endured.

During the recent reunion we had the opportunity to talk with **Ralph H. Berman** and his lovely wife, Edith. After M.I.T. Ralph worked for Raytheon in Waltham in radar development and then attended Cornell where he obtained an M.B.A. in 1950. Ralph eventually became the merchandising and manufacturing manager for radio and hi fi products for the Canadian subsidiary of R.C.A. Since 1958 Ralph has been engaged in the promotion and development of high-rise buildings in Montreal and environs. Ralph enjoys Montreal with Edith and their children, Brett, 12, and Patrick, who is nearly 8, but he is looking forward to doing some development work and to expanding his horizons.

Seymour Collins is now living in Campbell, Calif., with his wife, Virginia, and their children, Ellen, Clifford and David. After graduation Seymour spent a year on a patrol craft. For the following 15 years he worked with various companies in the construction equipment industry. He became president of the Ko-Cal division of the Koehring Co., which later closed for lack of a market for its products. Seymour is now president of Westfab Mfg. Co., a subsidiary of Consolidated Freightway, who manufactures springs for trucks and trailers, and the business is prospering.

Daniel D. Streeter, Jr., is spending 100 per cent of his time on research as a research associate in Biomechanics of the heart. He is in the pathology department of the University of Washington School of Medicine in Seattle. . . . Dr. **Nathaniel F. Rodman** is with the pathology department of the University of Iowa College of Medicine, and is establishing a laboratory. His aim is to continue his research in thrombosis and hemostasis with emphasis in the correlation of the blood platelet function and structure. I am sorry but I have no layman's explanation of the research program described above.

Gifford H. Stanton has moved from New York City to Hamilton, Bermuda. He is marketing manager for Gosling Bros., who bottle, wholesale and retail alcoholic beverages. Gifford and his wife, June, ask that classmates contact them if they visit Bermuda. The address is "Pretty Penny", Paget. . . . **Bill Phelan** is living in Lexington, Mass., with his wife, Margery, and their two children, David and Michele. The Phelans just celebrated their fourth wedding anniversary. Bill is teaching math in the Arlington, Mass. public schools.

We have word that **Richard J. Steele** has recently been accredited as a certified management consultant by the Institute of Management Consultants. Dick has his own firm, Richard Steele and Partners, Inc., in New York City, after spending his business life since graduation in the consulting field. . . . **Dave Sherrick** has sent a short note to tell us his son, Bob, will enter M.I.T. in September, 1972, as he has received his early admission decision.

Until next month, please write—**Russ Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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Recent mail has brought quite a bit on our upcoming reunion. It sounds like a fine time and I hope to see many of you there. The following letter from **Byron Lutman** was most enjoyable to receive just before Christmas and I would like to share it with you. For a bit of background, Nana, Byron and I introduced my wife Gina to the game of golf at the tenth reunion. "Nan and I are planning to attend the twenty-fifth with Bob and Peggy Schumacher. I have continued with Reliance Electric Company since leaving the Institute in 1948. Nan and I moved to the Chicago area this year after five years in Philadelphia. I am presently regional sales manager covering from the Canadian border to Tennessee and from Nebraska to Indiana. We really like Chicago. Our home is in Wilmette on the North Shore. I hope someone will line up a golf date while we are at the reunion. I don't play the game regularly any more, since I have reverted to my first love, tennis, so I have to watch out for a strong right hand when I play golf. You will recall that I hit a pretty squeaky hook anyway."

The clipping services advise that **Bud Palitz** has moved from president to chairman of Commercial Alliance Corp., a firm specializing in machinery leasings; **Harold Raiklen** has been inducted as an Eminent Engineer of Tau Beta Pi for his outstanding work in the aerospace field.

We regret to pass on the unfortunate news that **Francis Swain** died in October.

That is all the news for now but do hope we will have the pleasure of seeing many of you at our 25th in June.—**Dick O'Donnell,** Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

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Morton H. Levin is one of 19 engineers and applied scientists who are putting in a year of advanced learning at M.I.T.'s Center for Advanced Engineering Study. Morton is engineering manager for Hewlett-Packard, Medical Electronics Division, Waltham, Mass.

Micro Switch, a division of Honeywell, Inc., has appointed **Harry H. Meyer, Jr.** program manager for keyboards and high-performance dc motors. Harry joined the engineering staff of Honeywell in 1951. From 1963 to 1966 he was chief engineer of design in Honeywell's residential division, and he transferred to the Micro Switch Division in 1966. . . . **C. Vincent Vappi** has been elected Chairman of the Board of Technical Operations, Inc. Vappi and Company, one of the Northeast's major construction companies, was acquired by Tech-Op in December 1971. Vince joined the Vappi Company in 1948, and became its president in 1958. He has served his community in diverse ways; as a director of the Greater Boston Chamber of Commerce, and as a member of the board of trustees of the New England Deaconess Hospital, of Cambridge's Lesley College, and of the New England Aquarium.

The Ludlow Corporation, Needham,

Mass., has elected **Robert H. Welsh** to the position of senior vice president. He joined the company in 1948, and was elected a vice president and officer in the area of corporate purchasing and marketing in 1968. Robert will be responsible for manufacturing and research at Ludlow. . . . **Erik L. Mollo-Christensen** was a speaker at the Conference on the Interaction of the Sea and the Atmosphere held in Ft. Lauderdale in December. His subject was "An Approach to the Diagnosis of Environmental Problems." Professor Mollo-Christensen is a member of the Meteorology Department at M.I.T. . . . A recent note from **Kenneth A. Avery** advises that he has just recently completed 20 years service with the Electric Boat Division of General Dynamics Corp. He is now chief of their Marine Engineering Life Support, Hull and Special Weapon's Fluid Systems Design Sections.

Colby College in Waterville, Maine has announced the appointment of **H. Stanley Palmer** as plant engineer. He will have the responsibility of supervising and planning future alterations for the entire physical plant. Stan leaves M.I.T. where he has served on the engineering staff since 1958, and as superintendent of mechanical services since 1965.

I have been notified of the deaths of three classmates: **Ian H. MacDonald, Charles A. Gibbons** and **Claudio P. Segre.** Paul Erskine sent the following note to me: "It is with great sorrow that I learned a few weeks ago about the death of my friend, and our classmate, Claudio P. Segre on December 19, 1971. A note from his sister told of a sudden and tragic heart attack. Claudio graduated in course II and moved then to Buenos Aires. In the 1950's he moved back to Italy, living first in Torino and most recently in Milano. He was in business for himself and served as the Caterpillar Tractor Distributor in Northern Italy. Claudio leaves his wife Celeste and three sons." —**S. Martin Billett**, Secretary, 16 Greenwood Avenue, Barrington, Rhode Island 02806

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We start off this month with an announcement from our Class President, **Stan Margolin,** that **Leonard F. Newton** will assume responsibility for our 25th Year Gift Campaign. Scanning my class notes file, I discover that Len is a vice president and a member of the board of Opinion Research Corp. He has also been very active in community and alumni affairs. **Ira Dyer,** from whom Len takes over, will continue actively in the campaign.

The Technology Fund Notes this month look like a Lambda Chi Alpha Reunion. **Denny C. Kalette** confirms that he has assumed the duties of school business administrator for the Pomfret School, from which he graduated in 1942. That his family was happy to move to New England and that under the present Aerospace circumstances, the change from Bendix was timely. . . . **L. Brent Kuhnle,** Assistant Vice President of the J. A. Jones Construction Co., of Charlotte, N.C., reports that he is currently assigned as project manager—Bear Swamp Pumped Storage Hydroelectric Project—Rowe and Florida, Mass. . . . **Jack L. Baker** reports "I am one aerospace engineer who has solved his professional challenge, employment, and national need problems by going into executive recruiting. Since January 1, 1970, I have placed 30 professionals at salaries from $8,000 to $24,000, including three men over 60 years of age. Very popular now are cost reduction experts, EE (power), civil engineers, and salesmen with a following. Contact me at Management Recruiters, 2500 Packard Rd., Ann Arbor, Mich."

Thomas J. Whitlow has transferred recently to the radar division of the equipment engineering divisions, aerospace group, Hughes Aircraft Co. In this new job he is pursuing advanced programs in navy product areas. . . . **George F. Tomlinson** came back East in October '69, moving to the Department of City Development in Milwaukee, Wisc., from the Sonoma County Planning Department in Santa Rosa, Calif. He had been fairly active with the U.N., Santa Rosa, the California chapter of the A.I.P. and on the political scene in 1968 when he worked with posters and discussions for the Democrats. He reports that he would like to see planning in a new focus and that his wife misses California. (So does mine, George, and she left San Carlos in 1958.) . . . **Austin F. Marx** reports that he is now in his 11th year at Hewlett-Packard Company in Palo Alto, Calif., as manager, corporate planning and economics. Children, John (12) and Kathy (11) are growing up handsomely. He delivered a paper at the International Conference on Corporate Planning in Montreal in December 1971, and is a delegate to the International Affiliation of Planning Societies as past-president and director of the Corporate Planners Association. President-elect of Tau Beta Pi, San Francisco Peninsula Alumnus Chapter, Austin is listed in *Who's Who in the West* and *Who's Who in Finance and Industry.* He enjoys sailing, skiing, swimming, and piano in his spare time. . . . **Barbara (Feeney) Powers** went back to school last September when she accepted an appointment as assistant principal at Lafollette High School in Madison, Wis., a school of 2,300 students, and one of Madison's four high schools. She's the second woman administrator in Madison's High Schools and is pleased at her appointment.

A Christmas letter from **Jack Fogarty** reports that in January 1971 he became engineering section head of digital processing for the I.T.T.-Electro Physics Laboratories, now located in Columbia, Md., an all-new planned city between Baltimore and Washington. With 25 per cent of the land permanently retained as open space, with plenty of trees, schools with group-teaching based on learning programs rather than age, and a luxurious shopping area in downtown Columbia, it sounds like an interesting place to live. . . . From Rockford, Ill., comes word that **Charles W. Holzwarth** was appointed president of the newly formed National Lock Hardware Division of Keystone Consolidated Industries effective December 2, 1971. Congratulations, Chuck. . . . **William C. Schneider,** Director of Skylab Program for N.A.S.A., has called our attention to an article "Skylab and its Solar Astronomy Experiments" presented at the annual meeting of the American Association for the Advancement of Science in Philadelphia, December, 26-30, 1971. A manned orbital workshop due to fly in 1973, Skylab is designed to work in conjunction with the Apollo command service module. Bill Schneider's paper certainly demonstrates that the Skylab is a fascinating scientific project.

An article in the *Washington Post* last November presents a series of frightening pictures, excerpts of films prepared under the direction of **William Haddon, Jr.,** President of the Insurance Institute for Highway Safety. Each picture shows a small American car (Pinto, Colt, Vega, and Gremlin) being demolished in a head-on collision with a relatively-undamaged full-sized car from the same maker (Galaxie, Fury, Impala, and Ambassador).

Following that somber note, I'll take leave with some more pleasant personal news. My family and I are off to Saint Croix for our annual February visit to Estate Northstar as my father's guest. Almost immediately thereafter, I'm due to go to Rio de Janeiro, Brazil for several weeks on a consulting assignment. It should be an exciting and challenging trip, and a pleasant one if I don't return to find that Sonya has divorced me.

Don't forget to make an extra contribution this year to the Alumni Fund as part of our 25th Anniversary Gift. Best wishes to all.—**Frank T. Hulswit,** Secretary, 77 Temple Rd., Concord, Mass. 01742

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Lee Richardson has been appointed director of research and development for Foote Mineral Company in Exton, Pa. In his new assignment, Dr. Richardson will be responsible for research and new product development on a corporate-wide basis. He served with Oak Ridge National Laboratories, Los Alamos Scientific Laboratories, and Westinghouse Electric Corp. before joining Foote in 1963. He is a member of the American Institute for Mining Metallurgical and Petroleum Engineers, American Society for Metals, American Management Association, and Sigma Xi honorary research fraternity. He is a resident of West Chester, Pa.

Robert L. Whitney has been with Westinghouse Electric for the past 15 years. Currently he is a project manager responsible for three of their nuclear plants for Florida Power and Light, South Carolina Electric and Gas and Florida Power Corp. . . . **Douglas E. Strong** became a partner in the architect-engineer firm of Alderman and MacNeish in West Springfield, Mass., effective July 1, 1971. . . . In September of 1971, **Robert C. Michel** was elected president of the Kraissl Co., Inc., in Hackensack, N.J. . . . **David E. Webster** moved to Mississippi to enjoy the meaningful aspects of life—to enjoy his family, write, and run an $8,000,000 manufacturing company.

L. Richardson, '50

A. Elston, '51

W. Pinkham, '51

R. Nickerson, '51

Edwin B. Miller announces that he started the firm of Miller and Weaver Consulting Engineers, January 1, 1970—specializing in mechanical systems, design for buildings. . . . **Martin S. Osman** is currently working on new instrumentation techniques at the Polaroid Norwood plant. . . . **Norton Belknap** is still executive vice president and director of Esso Europe. 1971—a year of many problems but also some very enjoyable traveling.—**John T. McKenna, Jr.,** Secretary, 2 Francis Kelly Rd., Bedford, Mass. 01730

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Some of the following news was mailed in over a year ago. I hope it is all still current. From Denver, **Leonard Taigman** writes that the main attractions there are skiing and Martin Marietta, I assume in that order. Leonard and his wife have a son and two daughters. . . . After 19 years with Campbell Soup, **Dexter Whittinghill, Jr.,** moved to the William Underwood Company in Watertown, Mass., makers of deviled ham and B and M beans. The Whittinghill's are living in Lexington. . . . Also, from Lexington writes **H. Morse Payne** who has been with the prestigious firm, The Architects Collaborative since 1952. He is currently a principal and director there. The Paynes have two boys and one girl. . . . **George Meckert** writes from Huntington Valley, Penn., where he is president of the board of commissioners, executive director of the Pennsylvania concrete masonary association, developer of a small industrial park and, what's more, a grandfather!

The **Larry Schnecks**, living in Syosset, N.Y., were expecting their fourth child last summer. Larry is currently manager of financial data systems for Sperry Systems Management division. "We are developing an advanced stockbrokerage data-processing service to be provided, via remote terminals located at client brokerage offices. We are also developing related processing systems for banks and brokerage firms." A little late for some brokers, Larry. . . . At the University of California at Davis, **Myron Hoffman,** Professor in the Department of Mechanical Engineering is working on advanced power generation including magneto hydro-dynamics and controlled fusion (partly at the Lawrence Radiation Lab in Livermore.) . . . Our philosophical contribution for the month comes from our long time leader, **Art Wasserman.** "My wife and I saw M.A.S.H. recently and were disgusted by the willful insensitivity displayed toward the basic values of our civilized way of life—compassion, honor, dignity, heroism, nobility of spirit, etc. We must find effective, dramatic vehicles to counter these destructive propaganda pieces of an anarchial minority. Surely, the world provides enough heroic and noble stories of real men's deeds to provide the basis of inspirational film of high dramatic content. What do my classmates think?" Equal time will be provided to classmates wishing to support the anarchist point of view.

Artech Corp., Falls Church, Va., has made **Henry Hahn** president and board chairman. Artech was formerly the M.E.L.P.A.R. division of American Standard. . . . **Dan Maxfield,** who is with the department of transportation, has *five* sons and received a doctorate (business administration) from George Washington University in February, 1971. . . . **Martin J. Troster** has moved to Ridgewood, N.J. where he continues as manager of Sales Technical Services for Union Camp Corp. . . . After 17 years in the computer business with G.E., **Byron Burch, Jr.,** has switched to real estate and the Southwest. He is now with Tom Jackson and Associates, Inc., Scottsdale, Ariz. . . . Here is a man who really loves his work. **Dale Callahan** writes: "Still vice president of the dirty old foundry." Then he goes on about "beautiful Connecticut living", skiing, golf, swimming, and Hawaii. . . . Good news from Pillsbury: **Al Elston** was elected vice president of European operations. Al joined Pillsbury in 1969 and previously was in charge of the company's Latin American consumer businesses. Before that, he spent five years with McKinsey and Company, Inc. The Elstons live in Edina, Minn.

Bill Pinkham was named by the Trane Company's newly-formed Marketing Council, a group organized to help develop new products and marketing strategies. Bill has managed the Trane office in Newark, N.J. since 1964. . . . **Robert B. Nickerson** has been named vice president and general manager of The States Company, Hartford, Conn., a member company of Veeder Industries, Inc., engaged in producing testing equipment and related products for the electric utilities and the electrical manufacturing industry. . . . Received a note from **Lester W.** (Pat) **Preston, Jr.,** who I remember as one of the nicest guys in the class. He is director of scientific information for A. H. Robins, Richmond, Va. His wife, Kitty, an M.D. is a researcher for Robins. The whole family including 17-year-old son are sailing buffs. . . . From Niantic, Conn., **Daniel C. McKay, Jr.** writes that he is in business as a consulting civil engineer and land surveyor. . . . **Bob Gooch** was made a partner in the engineering firm of Freese, Nichols, and Endress, Fort Worth, on January 1, 1971.—**Fred W. Weitz,** Secretary, 4800 S.W. 74th St., Des Moines, Iowa 50321; **Marshall Alper,** Assistant Secretary, 1130 Coronet Ave., Pasadena, Calif. 91107; **John Dowds,** 1800 N.W. 18th, Oklahoma City, Okla. 73106; **Samuel Rubinovitz,** Assistant Secretary, 3 Bowser Rd., Lexington, Mass. 02173

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John T. Maxwell is now director of the new technical assistance center of S.U.N.Y., Plattsburg, N.Y. John is establishing a group of five professionals who will assist, through consulting, the many firms and agencies involved in the economic or industrial developments of New York's "North Country." The "North Country" is a 16-county area reaching from the Thruway to the Canadian border and east of Lake Ontario. John previously worked in the aerospace industry and was with Avco Corporation Government Products Group. . . . **Jack Larks** writes that he has a new position as Assistant Professor of Civil Technology at the University of Houston and that he also serves as a consultant for civil engineering. He invites any M.I.T. alumni who happen to be passing through Houston to stop and visit him at the campus. . . . A note from **John F. Clemons** indicates that he is now the assistant to the director of the research administration office at Children's Hospital Medical Center in Boston. Previously he worked as plant superintendent at the Medical Center. John's wife, Hope, gave birth to a son, Andrew, on January 13, 1971.

James H. Bunting is now working at Bowmar/Ali in Acton, Mass., as manager of calculating equipment engineering . . . . **T. M. Brown** is now working with the flight crew integration division at the

Manned Spacecraft Center. Tim is working mostly on the Skylab Program. He and his two sons, Murphy 13, and Mike 11, are active in the Boy Scouts. His daughter Sherry 11, is busy with pets; while his wife, Bunny, is involved in tennis and Houston's Wellesley Club Projects. . . . The Corning Glassworks, Corning, N.Y., has announced that **Rodney I. Frost** has been named engineering associate—mechanical in product development. Rodney has been with Corning since 1952 when he joined the company as a junior product engineer in the new products division. He has served in a number of engineering positions; and in 1970, was named senior product engineer in glass ceramic product developments. **Gene Erbin** writes that he and his wife, Joan, are enjoying life in Utah; particularly the skiing which is outstanding. All of the Erbins' six children are skiing. Gene is division manager of the N.L. Industries new magnesium metal division.

Here is another reminder. The Class of '52 Twentieth Reunion is scheduled for the weekend of June 2-4 at the Harborside Inn in Edgartown, Mass., on Martha's Vineyard. Please do not forget. Plan to come and see your classmates and their families. Bring your wife and children and plan for an enjoyable weekend. We'll see you there.—**Arthur S. Turner,** Secretary, 175 Lowell St., Carlisle, Mass. 01741

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The president of Concord Computing Corp., **Victor M. Tyler,** has established a new and potentially immense system. His company, located in Bedford, Mass., offers a computer controlled on-line credit authorization system that is beginning to find favor among retailers. Victor found the achievement of his present position "an interesting learning experience."

Dr. **Norman F. Ness,** Chief of the Laboratory for Extraterrestrial Physics of the Goddard Space Flight Center, received the Space Science Award of the American Institute of Aeronautics and Astronautics for "significant contributions to the description and understanding of the interplanetary medium and the interactions of this medium with the earth and other large bodies." . . . **Charles S. Robertson, Jr.,** is a consultant on analytic developments in the Nuclear Systems Programs Department of the General Electric Co. He is studying gas turbine automobile engines for the Environmental Protection Agency.

George Smythe reports that he is a project engineer in the Advanced Designs Laboratory of Control Data Corp. He, his wife Joanne, their two older boys and new baby live in St. Paul, Minn. George is active in the local chapter of the Experimental Aircraft Association. . . . In July of last year **Francis B. Curran** and his wife Jeanette celebrated the birth of their fourth son, Daniel Edward. . . . **Lester Lee** is now selling real estate in the Washington, D.C.-Montgomery County area until he finds a new business opportunity. . . . From **Bruce E. Landry** comes a note that he has served the West Seattle Kiwanis as president, and spends his spare time hunting, fishing, woodworking, and on Boy Scout activities.

The wife of **Oswald Fuzzer,** Mona, reports that the local attorney, Wazi R. Waznti, has succeeded in getting a few of the gift parcels into the jail. Thanks are extended to Larry Begetta for his farm produce, but Oswald says the broccoli spoils in shipment. Please, no more broccoli. Just a note about your current activities will suffice.—**Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winchester, Mass. 01890

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A belated Happy New Year to all. Sorry we missed the last issue, but our last deadline was two days before Christmas. . . . **Robert Ackerberg** is spending a year in London on a teaching sabbatical. If anyone has his address, please send it to us. . . . **Joseph Carleton** is working as a consultant on land and resource uses as they relate to current public policy. The summer of 1971 was spent with wife Ruth and two children touring the U.S. . . . **Bob Carlson** spent the last two years setting up the Babcock Graduate School of Management at Wake Forest and has now gone back to teaching. . . . In Miami, Dr. **Bill Calvert** is chief of radiology in the new Contract Larkin General Hospital which he helped found. In his spare time, he sails his 31-foot trimaran or flies to Vermont to ski. What a life!

Sabine and **Marc Forest** write that they enjoyed participating in the "Fiesta" held by the M.I.T. Club of Mexico and miss the intellectual stimulation of meetings at the Detroit M.I.T. Club. Marc has made several moves overseas in the employ of General Motors and would like to resume contact with friends who may have lost track of him. His address is: c/o General Motors Strasbourg S.A. 81 Rue de la Rochelle, 67, Strasbourg-Neurof, France. He also welcomes any alumni having interest in manufacturing or associated with G.M. Every other year the family spend five weeks in the States, and they plan to attend the next reunion. . . . **Ralph Gaze** just got his teaching certificate in Scottish country dancing! . . . **Irwin Gross** reports a year after the California earthquake that split apart his house that he is just finishing the extensive repairs and all is well. Irwin and Ann sent us an 11-page account of their frightening ordeal. The epicenter of the quake was within 15 miles of their Granada Hills home. Throughout the whole week of tremors they stayed there and hoped the cracked Van Norman Lake Dam would hold as they tried to clean up the mess, calm the children, and improvise a mode of life without electricity and water.

Carl Hanks writes that his company, World Resources, was a casualty of the 1969-71 "technology" recession and he is now a project manager—Special Systems, Space Systems Division, Lockheed Missiles and Space Company. . . . **Hans Hoeflein** has moved from Massachusetts to Virginia, continuing his duties as a district manager for Ingersoll Rand. . . . Dr. **Beldon Idelson** has been the director of the Clinical Renal Unit at University Hospital. He is doing research in nephrology and teaching in association with the Boston University Medical School. . . . If you need medical attention at the Atlanta airport, you would probably be brought to one of the offices of the Industrial Clinic Professional Corporation. This eight-year-old company is run by Dr. **Ed Johnson,** surgeon, and provides various types of health care under contract to major airlines and industry.

Professor **Dick Kane** is in Bristol, England. . . . **Jim Kellart** is with Fluor in the Netherlands. . . . **Bruce Loughlin** has sold his shares in Datatechnology, Inc., and is now with Data General and learning to fly as a hobby. . . . **Dick Mateles** heads the Department of Applied Microbiology at Hebrew University, Hadassah Medical School, and is director of the fermentation unit which is cosponsored by the government. His wife gave birth to their third daughter on December 28. . . . Dr. **Richard Peskin** is on the faculty at Princeton. . . . **Bob Pollard** has assumed expanded responsibilities as the vice president of marketing for the combined Hampshire Chemical and Polymer Chemicals Division of W. R. Grace. He's located in Nashua, N.H.

Dr. **Dave Quigley** is practicing orthopedic surgery all the way down in Providence. . . . Now that the weather is getting warmer, take the family to visit Mystic Sea Port, where **Don Robinson** of Noank is the associate director of the Marine Historical Association. He helps keep the "Charles W. Morgan" shipshape and promises all his friends a special tour. . . . **Michael Schiller** is chairman of the board and chief technical officer for Retrievex, Inc. in Riverdale, N.Y. They make an ultra-sophisticated automatic microfilm retrieval device that is attracting much interest in the field. . . . **J. Eric Schonblom** is completing his doctoral dissertation and teaching at the University of Florida in Gainesville. . . . **Richard Skavdahl** is manager of development and working on test programs in the breeder reactor department of General Electric.

Thomas Slater is executive vice president of Slater Electric in Glen Cove, N.Y. He makes electrical switches and reports business is turned on and the future looks bright! . . . **Tom Yonker** is in Helsinki. . . . Checking in from out California way, **Margaret Hughes Young** wants to make sure our questionnaire booklet was accurate on the lucky "man?" with the plane. Maybe it should have been "woman" since Margaret has one. . . . The government is sponsoring some of the advanced programs **Douglas Lowen** is working on in the Chrysler Space Division at Cape Kennedy.—Cosecretaries: **Bruce B. Bredehoft,** Knollwood Dr., Dover, Mass. 02030; **Mrs. Lloyd Gilson,** 35 Partridge Rd., Lexington, Mass. 02173

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THINK REUNION, the 15th is fast coming upon us—June 2, 3, and 4 is the time—Provincetown Inn is the place—Jim Cun-

ningham and the reunion committee are planning a memorable 15th anniversary get-together for the class. If you haven't already responded, dig out and answer the letter you received in February—**James E. Cunningham,** c/o IMAC Corp., 296 Newton St., Waltham, Mass. 021154—in case you lost the address. I'll be keeping you posted, as to more details of the reunion plans.

Business Week recently carried a long article on Norton Company's reorganization. One of the two new executive vice presidents is **Harry Duane.** Harry, who advanced at Norton through the financial side will head up the abrasive business which, in spite of Norton's diversification, still accounts for 60-65 per cent of total sales. . . . Jane and **John McAllister** dropped us a Christmas card from New Hampshire with the following notes: "Our first girl started school in the fall. Jane is getting ready to work on our 'first in the nation' primary. I'm still chasing electrons at Sanders." . . . Allegra and **Doug McIver** are now in California where Doug is working for Rand Corp. The McIvers have one child, a boy, aged two. . . . **Harry Margulius** writes as follows: "I have purchased, in partnership with J. K. Livingstone, a controlling interest in Data Technology Inc. I have been associated with Data Tech since leaving Draper Lab in 1969. Data Tech was formerly a division of Allen Bradley. I will serve as vice president." . . . **Don Aucamp** is now an assistant professor in the Department of Management Science at Southern Illinois University in Edwardsville, Ill. Don received his Sc.D. in applied math from Washington University in August, 1970. . . . Well, that's all for now. More in 30 days.—**Fred L. Morefield,** Secretary, c/o Mobil Oil Caribe, Inc., P.O. Box X, Caparra Heights Station, San Juan, Puerto Rico 00922

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Spring is here! Your secretary emerged from hibernation, saw his shadow (five o'clock), found a stack of news piled up, and decided he'd better not wait six weeks more to write the Class Notes. Happily, this task was brightened by a letter from **Serge Dyner** describing a recent adventure which should bring out the Walter Mitty in us all. "I sold my house back East and bought a motor home in which I took my family (wife, son, daughter and dog named Brandy) all over the U.S. and Canada from July to December 1970. This proved to be a tremendous family adventure and educational experience for us all. We finally settled in what we feel to be one of the most beautiful and promising spots in the U.S. I am now project architect on a high-rise condominium project for "Snowbird"—a new ski resort community in Alta, Utah."

Paula and **Herbert Waxman** wrote that they are "finally settled with our three children in Gladwyne, just outside of Philadelphia, where Herb is associate professor and deputy chairman of the Department of Medicine at Temple University School of Medicine." . . . **Paul Knopf** has been appointed to the position of associate professor of medical sciences at Brown University beginning in 1972. . . . **James Tillman** is working at the University of Washington in the Department of Atmospheric Sciences. Jim and his wife are living in Seattle with their two children, aged 6 and 7 years. . . . A short note from **Daniel Brand**: "I have left engineering temporarily to become a 'planner', as they are known. At least that's what my appointment as associate professor of city planning at Harvard would seem to mean." . . . **Siegmar Silber** was admitted to the New Jersey bar in December 1970. Currently he is with Otis Elevator Company at their New York City offices where he is handling some of their patent and trade-mark work. . . . During the past summer, **Richard Klafter** served as associate project director of the N.A.S.A.-A.S.E.E. summer systems design study held at Langley Research Center. His summary of the program was "twenty-three college professor types produced a report entitled 'Clean Water: Affluence, Influence, Effluence (A Design for Water Quality Management)'. (Say that fast three times)". . . . **Greg Lazarchik** reports that he has recently moved to a new home in Mt. Lebanon, Pa., with his wife and their four children ranging in ages from 11 to 1. Greg writes, "Most of our summer was spent redecorating the new home. Currently I am product manager for organic chemicals at P.P.G. Industries." . . . Recently had lunch with **Bob Fulks** here in Concord, Mass., where both of us are working. Bob is at General Radio where he is now vice president in charge of engineering and marketing. He and his wife now have two children, age 13 and 11, and the whole family is active in local town affairs. They have just recently built, and are still in the process of completing, a new house.

International Scene

A communique from **Tom McClimans** reports that "after six years as a research assistant in Oslo, I am now an oceanographer in Trondheim, Norway. Else and I are enjoying life and our daughters Else Leona, 3, and Kari Elfrid, 2, are doing fine." . . . On the business scene, **Michael Barth** reports "I have my own company Capi-Compagnie Auxiliaire Pour l'Industrie—located in Geneva, Switzerland. As the name implies, we provide marketing services to companies and businessmen. These services are both practical and advisory in nature in the areas of finding and developing new markets as well as on how to obtain maximum yield in each European country. We also act as a company's central office out of Switzerland. Geographically, we cover all of Europe."—**Michael E. Brose,** Secretary, 30 Dartmouth, Boston, Mass. 02116

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Our Class Hero of the month is **Jim Rome,** who wrote to tell me that he is now my Tennessee neighbor—in Oak Ridge (even if it is 400 miles from Memphis!). After 11 years at M.I.T., Jim received his Sc.D. and is now in the thermonuclear division of the Oak Ridge National Laboratory. His bachelor pad is in operation, but he says that the town is not exactly running over with eligible females. . . . Meanwhile, back at M.I.T., **Ned Block** has been appointed an assistant professor in the department of philosophy. . . . And even farther back at M.I.T. **John Carlin** states that now that it's been seven years since he left M.I.T. and the statute of limitations has expired, that he did most everything he was accused of! . . . **Howard Cedar** is serving in the Public Health Service at the National Institute of Health in Bethesda, Md. He and his wife Zipora have two children . . . **Ambrose Clay,** the 1971 Alumni Fund chairman for Oak Park, Ill., and **Jim Giffin,** our Class Agent, have received certificates of appreciation from M.I.T. for their efforts in last year's fund raising.

Barbara Cohen is media director of Complan, Inc., which handles industrial and business advertising accounts. She is also in her second year of law school at the Lincoln Center campus of Fordham University. . . . **R. B. Colvin** is on a training fellowship in pathology at Mass. General Hospital. His wife Gay gave birth to a girl last August. . . . **Dave Dunford** is the Economic-Commercial Officer at the American Embassy in Helsinki, Finland. He and his wife Sandi have two children. They expect to return to Washington this July . . . **James Flink** is an assistant professor at M.I.T. in the Department of Nutrition and Food Science following a year and a half as a guest professor at the Technical University in Denmark.

Joe Hollweg is a research fellow in theoretical physics at Caltech, where he also teaches an introductory plasma physics course. . . . **Doug Hoylman** is an adjunct assistant professor of mathematics at both Staten Island Community College and Notre Dame College of St. John's University. . . . **Kenneth Kaiser** states that he teaches hockey at M.I.T. in addition to his other activities. . . . **Bob Levis,** who was captain of the M.I.T. fencing team, recently won the Puerto Rican National Championship in Epee. Bob works at the Puerto Rican Cement Co. and his wife Elisa is the top female chemist at the Bacardi Rum Co. (Let's hope they don't mix their products together, or they might have a lot of intoxicated concrete in Puerto Rico!) Bob spends a good bit of time with his fencing, and has recently travelled to Colombia and Cuba for tournaments.

John Ludutsky and his wife took a vacation trip to Fiji, New Zealand, and Australia last year. . . . **John McNamara** is working in the PDP-11 Communications Group at Digital Equipment Corp. in Maynard, Mass. He reports that **Don Alusic** is also in this group . . . **John Meriwether** is spending the winter in Fairbanks, Alaska as part of his research on aurora for the University of Michigan. He is engaged to a Ukrainian girl from Brooklyn. . . . **Duncan Miller** is a senior scientist at Bolt, Beranek and Newman in Cambridge, working on models of man-computer interactions. He has a private pilot's license and enjoys flying with his wife Holly, daughter Kristin, and their second child who is still on its way. . . .

John Moter is a section manager in the digital systems lab of Raytheon Missile System Division. He and his wife Juta have recently bought a house in Westford, Mass. . . . **Larry Rabiner** is with the acoustics research department of Bell Labs in Murray Hill, N.J. He was recently elected a fellow of the Acoustical Society of America. . . . **Donald Reed** is an associate of the firm of Haley and Aldrich, Inc., consulting soil engineers in Cambridge. He is in charge of the geology and engineering geophysical group.

Anthony Robinson has finished his third year of psychiatric residency at the Boston University Hospital. He will begin a two-year stint with the Air Force this summer. . . . **Christopher Ritz** has been awarded an assistantship in the department of quantitative analysis at the University of Cincinnati. . . . **Maury Shulman** is a systems engineer for I.B.M. in Philadelphia. He and his wife Rena spent their second wedding anniversary on a recent trip to Europe and Israel. . . . James Spencer and his wife, the former **Nancy Casella,** have both joined the staff of the Los Alamos Scientific Laboratory in New Mexico to work with the Medium Energy Physics Division. James received his B.S. and Ph.D. degrees in physics from M.I.T. and Nancy received her B.S. in mathematics there. . . . **Michael Stulbarg** has completed his second year of residency in internal medicine, to be followed by two years of fellowship. . . . **Don Torrieri** is with the Naval Research Laboratory in Washington. His wife Nancy is a graduate student at the University of Maryland, where Don received his Ph.D.

Doug Tuggle recently presented a paper at the Tokyo A.I.C.A. Symposium on the Simulation of Complex Systems (the program put together jigsaw puzzles!). Don received his Ph.D. last May at Carnegie-Mellon University. . . . **James Wasvary** and his wife Jong, a native of Seoul, Korea, are both biochemists with C.I.B.A. Pharmaceuticals in Summit, N.J. . . . **Edward Wolcott** is presently developing a lead-acid rechargeable battery for the Gates Rubber Co. He and his wife recently became the parents of a new arrival, a daughter. . . . **Bill Young** is an organic chemist for I.B.M. in Yorktown. He organized and presented a paper at a symposium on liquid crystals held at the American Chemical Society's national meeting last September.

That's it for this month. Let me hear from you.—**Ron Gilman,** 5209 Peg Lane, Memphis, Tenn. 38117

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After a two-month delay between issues, the stock of Alumni Fund envelopes is adequate for a reasonable column. But it is still prudent for me to encourage the writing of letters for future columns. Consider yourselves encouraged.

New Old Classmates

An individual's class affiliation is determined by his year of graduation, the Alumni Office computer, and his own preference. Two classmates have expressed their preference and rejoined '65. **Aaron Goldberg** (who received S.B. and S.M. in 1967) is now with the Defense Communications Agency in Reston, Va. Aaron married the former Ellen Intriligator of Westfield, N.J. in May, 1969. The following spring he received his Ph.D. in electrical engineering from Tech with a thesis on visual speech aids for the deaf. Aaron has been at D.C.A. since July 1970 and works on secure voice communication for the government's worldwide network. He reports that the government now seems to be where the action is—and one of the few places where engineers can find work. . . . **John Memishian** has also rejoined the Class of '65 (from '66). John is working for Raytheon and lives in Arlington, Mass.

Yet More Doctorates

John Freed completed his Ph.D. in organic chemistry at Stanford in January 1971. He is now doing post-doctoral research in immunology at Stanford Medical Center. . . . **Michael Graham** is at Berkeley hoping to finish a Ph.D. in biophysics by June. Previously he spent two years in the navy at the Armed Forces Radiobiology Research Institute in Bethesda, Md. . . . **Harry Ellis** got his Ph.D. in pharmacology in June, 1971. Harry is now a research pharmacologist at Walter Reed Army Institute of Research and a Captain in the Medical Service Corps.

Family Notes

Ann and **Will Frangos** have two children now—Jennifer (born in 1968) and Colin (1971). Will reports that Colin is an aspiring football player, having been born at 11 lbs., seven ounces and growing along the normal curve: this extrapolates to roughly 320 lbs. at maturity. The Frangos' live in Salt Lake City where Will works for Kennecott Exploration, Inc. as a geophysicist in charge of exploration for metals in California, Nevada and Utah. Will says they haven't found anything recently and calls that his own form of environmental protection. His parting thought (in a nice long note) is that peace and prosperity can be compatible. . . . The **Gary Roses** have a new arrival—Jeffrey Gary Rose. Gary is still working for Pan American Airlines and has returned to New York City. . . . **Mark Hanson** announces the birth of a baby daughter, Molly, on September 8, 1971. The Hansons have bought an old country inn in Stow, Mass.

Pat McCloskey Graham temporarily retired from chemistry last summer to care for her first son, Christopher, born August 29. Pat received her M.S. in chemistry from Stevens Institute of Technology just in time (May 1971) not to use it. . . . **George Lee** was married last November. George and wife Susan, a teacher, live in Torrance, Calif. George is still working for T.R.W., now in discrete computer simulations. . . . Rose and **Don Smith** recently bought their first home in Westport, Conn. Their only daughter, Laura Nicole, is now two years old. Don is still in research at Perkin Elmer in Wilton, Conn. . . . **Jerry Goldenberg** is married to the former Ellen Heinberg of New Bedford, a music graduate of Ithaca College. Jerry is with Sanders Associates in Nashua, N.H. as time-sharing section supervisor of Corporate Analysis and Computation.

Moving On

J. D. Roach, his wife Pamela and daughter Vanessa are moving back to Boston where J. D. will join the Boston Consulting Group. J. D. has spent the last four and a half years with Northrop Corp. in Los Angeles. His last position at Northrop was assistant to the general manager, associate with Northrop Technology Development (a venture capital subsidiary), and director of management Information Systems and Contract Accounting. . . . **Alan Schutz** is now the director of engineering at Frequency Devices in Haverhill, Mass. Alan is in charge of new product development. . . . **David Lerner** earned his M.S. in 1967 and worked for Instrumentation Laboratory. He then moved to London and worked at odd jobs in pubs and local schools while he tried to get an oceanographic instrumentation company off the ground. David's draft board interfered with his entrepreneurial instincts and he is now (30 months later) working for Litton Data Systems, married, and anxious to renew acquaintance with old friends.

Last Note

Jim Hester's Christmas card mentioned that he got his initiation as a New Yorker when he was "mugged by three fine friends." No harm done and Jim says they even caught two of them. . . . And that's the news. It has been a strange winter in Boston (through mid-February) this year. I went cross-country skiing last week in Stowe, Vt., but even that far north they got rain in yesterday's storm. Next weekend, Canada?—**Steve Lipner,** 3703 Stearns Hill Rd., Waltham, Mass.

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I've visited **Dave Sanders** a few times recently. Dave is still working for Hewlett-Packard as a marketing product manager in the minicomputer operation. Last fall Dave and a business school classmate spent an enjoyable vacation in the Orient. Dave enjoys living in the San Francisco Bay area. Still a bachelor, he often heads for the ski slopes on the weekend. . . . Another bachelor, **Henry Heines,** sent a letter from Berkeley. He writes: "I obtained my Ph.D. in chemical engineering with a minor in mechanical engineering from the University of Illinois in September, 1971. It was not until a month later that I secured a job after a frustrating year-long search of over a 100 different possibilities. I now have an excellent position as research engineer for Stauffer Chemical. The job is demanding but very stimulating. Many people in the company have either graduated from or were associated with M.I.T. What makes it even more appealing is the San Francisco Bay area."

Roger Kirst sent a Christmas card from Patuxent River, Md., where he has been for about a year. Roger is an assistant legal officer in the navy, and his work involves trial work, legal counseling, and paperwork. His wife Helga, also a lawyer, is working in a small law firm. Roger and Helga visited London, Holland, and Den-

mark last September. . . . **Mike Cohen** spent last year selling medium scale computers in Europe for Digital Equipment. . . . **Alan Sloan** joined Sutherland Learning Associates in September as executive vice president. . . . Lieutenant **Paul Tarantino,** U.S.N.R., has been transferred to Japan for a tour of six months. He has not yet planned his post-Navy future.

Diane and **Don Berliner** are swinging along quite well after a traumatic few months in which Diane broke her leg in two places in an auto accident. "Things are quite a lot better now after that unlucky break!" . . . **George Solomon** is chairman of the applied science department at Olive Harvey College, a city college of Chicago. . . . **Jeff Shapiro** has his first child, Lisa Ann, born August 7, 1971. . . . **Terry Collins** is working on his Sc.D. in computer science at George Washington University. He is still single. . . . **Robert Trunek** is still plugging away at project engineering with Arco's Houston refinery. He is attached to a local navy reserve unit. . . . **John Ross** writes: "In June of 1970 I took a most enjoyable plunge and married the former Myrna Sloan of Lynn, Mass., and Brandeis, '67. Since then, besides living in wedded bliss, I have been teaching and working on a Ph.D. thesis at the M.I.T. department of chemical engineering. With luck I should be nearly finished by the time of our reunion." . . . After a ten-month "vacation" due to cutbacks, **William Weber** has switched his career objective from electrical engineering to computer sciences. He is working for Litton Industries in Woodland Hills, Calif., as a programmer and analyst.

Rick Murphy received his Ph.D. in mechanical engineering in February, 1971, from M.I.T. He is living in Arlington, Mass., and working for Raytheon in Bedford. . . . **Eric Goeld** designs integrated circuits at Harris Semiconductor. He married the former Cheryl Newman of Boston, February 12, 1970. . . . **John Ellenwood** writes: "I made my first trip back to Boston with my family since starting artificial kidney treatment two years ago. I had a couple of treatments at Peter Bent Brigham Hospital in their crowded and expensive facilities. I had forgotten what humid weather was like and must say that I was glad to get back to the state of Washington. Are any other readers on artificial kidney?" . . . **Paul Caragine** is enjoying his work as a straight surgical intern at Martland Hospital in Newark, N.J. He will begin residency training in orthopaedic surgery in July.

Joel Berk has returned to Columbia for his doctorate in business administration. His wife Nancy has given birth to a daughter, Michelle. . . . Jan and **John Rudy** bought a house in Lexington that manages to keep them quite busy. Now that John has moved from Cambridge, he no longer will run the Cambridge fund drive. However, he will head the fund drive in Lexington, and he could use some help. . . . **Robert Sitrin** has passed his oral exams and will soon receive a Ph.D. from Harvard. He is going to Basel, Switzerland, for a post-doctoral appointment at the Woodward Research Institute. His wife Miriam is expecting their first child in May. . . . Since graduation **Dave Bailey** has been working for the Department of Defense. This work was interrupted by two years of involuntary service in the army; the closest he came to Southeast Asia was West Germany. Dave is now working on a master's degree in computer science at University of Maryland.

Mark Grossman bought a new home in Princeton. He is both working at R.C.A. and studying for a Ph.D. in statistics at Rutgers. . . . **William Lange** is working in New York for American Airlines. He and his wife Linda have two children. . . . **Rick Dower** has been teaching physics, coaching cross-country, directing plays, and living in a dormitory at Milton Academy. . . . **Francis Walsh** is in the M.B.A. program at Harvard. . . . **Greg Zacharias** has been working on a space shuttle reentry design.—**Jim Swanson,** 508 Thompson Ave., Mountain View, Calif. 94040

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The wandering Marcus household has finally found a home. We recently bought and moved into a house in Falls Church, Va., about 10 miles from Washington, D.C. It is a ranch style house and has a large lot—one-third-acre. Does anyone have any gardening tips? Gail is working at Analytic Services, Inc. a small think tank that works for the Air Force, while I'm actually in the Air Force fulfilling my old A.F.R.O.T.C. commitment. I'm assigned to the V.E.L.A. Seismological Center in Alexandria, which is a small group studying methods for detecting underground nuclear explosions. In the same group is John Woods '65, who also received a Ph.D. in Course VI. We are looking forward to meeting other classmates in the Washington area.

For some reason we have only one wedding to report. **Doug Wilson** was married to the former Christine Jackson on August 7. He is now back at the University of Colorado and is about to take his comprehensives in astrophysics and start a thesis. Until January 1971 he was in the army and stationed at Aberdeen Proving Grounds. Doug reports that he does not miss his former employment. . . . **Richard Johnson** writes that since he left Boston he has completed a master's in physics at the University of Michigan, spent six months as a caseworker in the Detroit Welfare Department, and spent exactly 365 dismal days unemployed. He is now working as an attendant in the children's psychiatric hospital at Pontiac State Hospital and hopes that this will count as alternative service as a C.O. . . . **Herb Finger** is alive and healthy working for N.A.S.A. Ames Research Center. He is still playing lacrosse for the Palo Alto Lacrosse Club but is thinking about moving back to Beantown because he misses the snow. On May 19, he will turn 26. . . . **Tom James** has returned from Saigon, and he left the navy on November 12. While overseas he became the proud father of a son named Thomas Morgan, so he came home to a seven-month-old son and a daughter, Tiffany Ann. He is now working for the engineering department of Shell Oil in Detroit.

Pete Amstutz writes that he is enjoying life in Fun City. After receiving an M.B.A. in June 1969 he spent four months abroad to see the world. His funds expired after seeing 17 European countries and traveling 10,000 miles. He was in Prague a week after Dubchek was ousted and was in East Germany during its 20th birthday celebration. He is working now as a securities analyst on Wall St. for Smith, Barney and Co. In his spare time he is "soaking up New York's culture, studying languages at night, and fighting to destroy New York's number one pollution problem: too many women." . . . **Burton Rothberg** is in the doctoral program at Harvard B School and is also doing consulting work. . . . **Tom Romer** is in what he hopes is his last year in a Ph.D. program at Yale. . . . **T. B. Griswold** hopes to finish his Ph.D. in geology this summer, but he is still looking for a job. . . . **Bob Anthonyson** is treasurer of Dynamic Associates, a software programming and economic and management consulting firm. Also in the firm are **Leonard Schrank,** Robert Pindyk, and Mark Eisner.

Rich Lufkin reports from the U.S.S. *Independence* that he was promoted to Lieutenant (j.g.) on September 3 and expects to be transferred to another ship. He will rejoin the civilian world in May 1973. . . . Last June **Mike Krashinsky** finished all his written and oral comprehensives in the Ph.D. program in economics and he looks forward to two peaceful (?) years of thesis writing, other research projects, and teaching. "The thought of no more formal courses is refreshing". Mike spent last summer working with kids at a summer camp and even squeezed in a trip to Stratford, Ontario. . . . **Barry Mitnick** spent the summer working at the Foreign Policy Research Institute in Philadelphia and taking courses. He comments that Philadelphia is not the nicest place to spend a summer. This year he has an N.S.F. traineeship which along with some continued support from F.P.R.I. means he is financially OK. He is now finishing his study of political science and trying to explain how that blends with a physics background.

That's all we have now. See you next month.—**Gail** and **Mike Marcus,** 2207 Reddfield Dr., Falls Church, Va. 22043

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We will begin this month's installment with a note from **Robert G. McGregor** who is currently an army earth-moving platoon leader. Bob is travelling around Europe visiting construction projects while learning the ins and outs of earthwork and heavy machinery. Although Bob finds his present travels to be a great experience, he does not plan to make the army a career. . . . **Robert von Saal** has moved from Gibbs and Cox, Inc. to a position as a naval architect with J. J. Henry Company, Inc., of New York City. . . . **David C. Silverman** is presently in the Ph.D. program of the chemical engineering department at Stanford Univer-

sity. Dave is working in the bioengineering group of the department on a project tied in with research at the Palo Alto V.A. Hospital and the electrical engineering department. Along non-academic lines, Dave finds the weather to be great but misses the more active Boston life at times.

Roger Chang has been promoted to a captain in the army and has finished his first assignment with graduate civil schooling at the University of Michigan. Roger has received his electrical engineer degree and his M.S. in industrial engineering. His wife Lula has received her bachelor of fine arts degree.

Rick Sline has been transferred to the Baton Rouge office of Sline Industrial Painters where Rick is working as an estimator and safety director. Rick and his wife Royce Ann are proud parents of a one-year-old son Daniel. . . . **William Stewart** is currently teaching electrical and mechanical engineering as an instructor in a technical college. He recently married Jennifer Huffman. During the summer Bill works for his father as a materials handling engineer.

Peter Georgi has been teaching eighth grade mathematics since graduation. Because Peter's draft board has been rumbling in his direction lately, he is unsure of his future plans but cites law school as a possibility. . . . **Carl Everett** is married to the former Julie Lund of St. Paul, Minn., who graduated from Lake Forest College in June of 1971. Carl is studying law at the University of Houston while working part-time in an environmental law program. . . . **Douglas Flower** is enjoying life in Toronto with his wife Maurene whom he married in June 1970. Doug is working for I.P. Sharp Associates, at present designing a list processor for A.P.L. . . . He and Maurene received a visit last September from **Mark Braunstein,** "who made delicious crêpes suzettes." . . . **Edward M. Waibel** is finishing his second year of the M.B.A. program at the Harvard Business School. He plans to graduate in June 1972 and hopes to find employment in either New England or the San Francisco area. . . . **Joseph Horton** will be finishing medical school on or about February 24, 1973, after which he and his wife Susan will vacation somewhere for a month before taking up an internship or residence.

Austin Napier was a graduate student in the physics department at M.I.T. until his induction into the army last June. He is now in the S and E program at Picatinny Arsenal. After completing his service obligations, he plans to return to the 'tute. . . . **Michael Warren** married the former Phyllis Lynn Paltrowitz on June 28, 1970. Phyllis was a 1970 graduate of Boston University. A son, Matthew Scott, was born on December 24, 1971. Mike is presently pursuing his Ph.D. in control theory with the M.I.T. electrical engineering department. . . . **Mark Lively** is now employed by American Electric Power Service Corporation and is living in New York City. Mark writes, "The barefoot boy from Kentucky wants to go home to the hills." . . . **Patrick R. March** married the former Marion Setterlund in October 1971. Pat is currently unemployed.

George J. Caporaso is a lieutenant with the navy, presently stationed in Okinawa. His wife, the former Josephine Russo, a '71 graduate of Northeastern University, and George plan to return to the U.S. after George completes his hitch with the navy. Upon returning, George expects to continue at M.I.T. for his master's degree.

George J. Flynn is now editor and publisher of the magazine *Model Rocketry.* . . . **Anne S. Hirsch** has been appointed by M.I.T. as an industrial officer. Anne is a teaching assistant in the department of ocean engineering.

As for myself, I will be graduating from Harvard Law School this June at which time I will have to gather all my junk from four years at M.I.T. and three years at Harvard and move out to St. Paul, Minn. I have accepted employment with the law firm of Oppenheimer, Brown, Wolff, Leach and Foster in St. Paul. It will be strange to start working for a living. Keep the letters and notes coming in. —**Richard J. Moen,** 412 Hastings Hall, Cambridge, Mass. 02138

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Spring Greetings! Boston is undergoing metamorphosis to warmer weather, green buds promising beauty and friendlier smiles. We believe that you should find this a diverse and, we hope, interesting column.

Department of Education

Michael Hoffman is in his second year of graduate studies in mathematics at Berkeley. We had mentioned in a previous column that **Nicholas Escott** was attending McMaster Medical School in Ontario, however we failed to reveal that he had worked for Control Data of Canada before entering school. **Thomas Hafer** has been awarded a master of science from Iowa State University. . . . **Ernie** (Tex) **Nall** and **Kerry Simpson** have rejoined the ranks of the undergraduates at M.I.T. after about a one-year layoff. Evidently, the Sloan School of Management is more appealing than interior painting and design work. . . . **George Allen** spent the summer enjoying San Francisco and returned with a Husky pup, Thane. George is working on his Ph.D. in nuclear engineering and shares a large house in Winchester with Ernie, Kerry and several other students. . . . **D. Wayne Wenger** is considering preparing for foreign service by pursuing a graduate degree in business or economics. He is working for Procter and Gamble as a computer systems analyst for their advertising of health and beauty products.

Department of Defense

Barry Field writes that he is now a private first class in the army and is studying Russian at the Praesidio of Monterey. He also tells us that he is happily married. . . . **Antonio de Jesus Villa** is also in the army and is married. He is working as a pharmacist's assistant in Germany. . . . **Anthony Malensek** is a lieutenant with the sixth battalion of the 92nd infantry at Fort Hood, Texas.

Department of Matrimony

A. M. (Sandy) **Harlow** was married to the former Miss Marilyn Williams (Wellesley) on January 29 in Westport, Conn. Sandy graduated from the Sloan School with a M.S. and it is rumored that he may be joining Proctor and Gamble. . . . **Terry Michael** will be married to Miss Bonnie Paulsen (Wheelock) on May 29 in New Hampshire. Terry will receive a master's in industrial administration from Carnegie-Mellon. Having rowed heavyweight crew for M.I.T., he has also found playing defenseman on a local Pittsburgh amateur hockey team much to his liking. . . . Most of the information in this section of the column has been supplied to us in a nice letter from **Carl Yankowski.** He also writes that his wedding to Miss Sandy Griffith (West Virginia Medical School) is definitely on June 10 in Wheeling, W. Va. I will be attending the event with my wife, Penelope, and hope to make it a pleasant ending to a week of planned vacationing in the Central Atlantic area.

Department of Labor

Ben Wilson recently attended a General Electric orientation conference held near Lake Placid, for the members of the technical marketing program. The conference helps the members in choosing one of the available career areas. Ben, as you might recall, was an outstanding performer in M.I.T.'s athletic program and three-time small college All-American in track. . . . **R. F. Tinker** wrote a note telling us about a center he is starting for Ralph Nader that is composed of scientists. He urges that all those interested write to him. Unfortunately I am unable to relate to you his mailing address. . . . **Lonnie Von Renner** is a professional staff assistant for the Committee on the Interplay of Engineering with Biology and Medicine with the National Academy of Engineering.

Robert Schmidt spent six months in Fort Polk, La., training with the New Jersey Army Reserve National Guard which he states was not much of an intellectual exercise. However, he has found some challenge as a systems analyst/programmer for Westinghouse in Lester, Pa. . . . New Haven runs a poor second to Cambridge as a living place, according to **Lewis Austin,** but he enjoys teaching there. . . . Since the last writing, **Joe Baron** has taken a vacation trip to California and directed a wrestling tournament in Pittsburgh where he is apparently employed by Westinghouse. . . . We received a long letter from **Bob Dennis** who has been promoted to assistant to the budget director of the Human Resources Administration of the City of New York. Bob is somewhat amazed that he is still alive after six months in the "City." Although gaining valuable experience and knowledge, he states that he hasn't solved the "urban crisis" and also dislikes the high costs, exorbitant rents and the subways. . . . On a sunnier note, **Steve Chamberlain** has moved his chess board from Atlantic City to Tampa, Fla. Steve has done a lot of traveling, but he says that Tampa is the best city that he's ever been in and is looking for a job.

Department of Short Notes

An informative letter from **Paul Zimmermann** reached our hands recently. He is working on a Ph.D. in astronomy at Berkeley. **Richard Voss, Marvin Hymowech** and **Max Tabak** have also been seen frequenting the same classes. **Tom Walton** who has received a master's degree from North Carolina State University wrote to Paul revealing that he was going to work to pay off old tuition bills and was planning to eventually go into religious work. . . . Tom also reported that **Gary Rochelle** was working in Durham, N.C., for the public Health Service. Paul continued by saying that **Dan Carrier** was working in the same M.I.T .Psychology Department office where he and **Pam Whitman** used to work. Finally, he related that **Craig Steinfield,** who had also worked there, was teaching high school math in Boston.

Department of Business

Fellow classmates, we assume that you have received the class letter sent to you by our President, **Steven Carhart.** In review, our gift was the annual funding and selection of a research project in an area of social responsibility. At this time a committee is being formed to carry out our class' desire. Evidently the $4000 in presently-held funds is an amount large enough to initiate action. The rate of contribution of funds is very nearly the same as that of the Class of '69 for their seminar series. As a matter of information, the Class of '71 is funding the Kent State Memorial Lectures, which bring to focus important issues of the day. We believe that the gift from our class is a viable function and your participation and ideas are most welcome. For those of you who have forgotten, your class officers participated in a telethon to you just hours before the announcement of the invasion of Cambodia.

We would enjoy some letters containing suggestions or comments on past columns, analysis and/or class news. The column depends upon your participation. In a previous issue the class noters listed the initials of **Peter M. McCall Jr., John R. Confrey, James R. Hamerly** and **Edward J. Chalfie.** The response was as good as that of the poetry contest of our first column.

Department of Controversy

"We have medicines to make women speak; we have none to make them keep silence. . . ." This is a quote from Anatole France's *The Man Who Married a Dumb Wife.* Demetrios Matsakis '71 has taken exception to the intended meaning by interpreting the quote as being "abusive of women." We do not intend to publish a recognized literary work for literature's sake without analyzing its message for appropriateness. At this time, assuming that critics are usually the most vocal, we have not heard one other objection from any other group or individual. We are, nevertheless, always receptive to comments constructive to our purpose.—**Robert Vegeler,** Class Executive Committee, 511 Beacon St. A-9, Boston, Mass. 02115; **Laura Malin,** Secretary, 406 Beacon St. #1, Boston, Mass. 02115

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Welcome to the first edition of the Class of '71 notes. We are still at the 'Tute finishing double major programs, hoping to graduate this June. M.I.T. has been politically calm this year. This calm has allowed us to forget such things as Kent State. This is good in that it indicates that there have been no similar events to remind us, but it is also bad because we forget the need for communication and understanding to prevent such events in the future. This is, of course, leading up to a plug for the Annual Kent State Memorial Fund. In the interests of promoting political awareness and social consciousness within the M.I.T. Community, the Class of '71 decided to organize and raise funds for an annual debate or panel discussion on the problems of the day, from pollution to international affairs to the crisis in educational finance.

If anyone wants to pledge or send a contribution please send it to the Kent State Memorial Lecture, M.I.T., E19-437, Cambridge, Mass. 02139. . . . **Lee Scheffler** and family (Vicki, his wife, and Susie and Smidgeon, his cats) are living in Waltham two blocks from the Newton dump. He's in the M.I.T. E.E. department's Ph.D. program, doing research at Project MAC. . . . **Andi Sanders** (Bubbles) is living in Cambridge and doing graduate work in education and chemistry at B.U. She wants to teach chemistry. . . . **Pete Rossow** and **Janet Koch** married last year and are now living in Eastgate. Pete, who mixes the best drinks in the Boston area, is at Harvard and Janet is at M.I.T. . . .**Bill Haggerty** is living in Dorchester, reading science fiction books and playing night watchman. In his spare time he attends B.C. Law School. . . . **Paul Snover**—class secretary—where are you? . . . **Bruce Rummel** took off for Seattle in September to seek his fortune. Well, he's back in Cambridge, looking for a job. . . . **Mike Gilmore** is in Moscow, Idaho at the University of Idaho Law School.

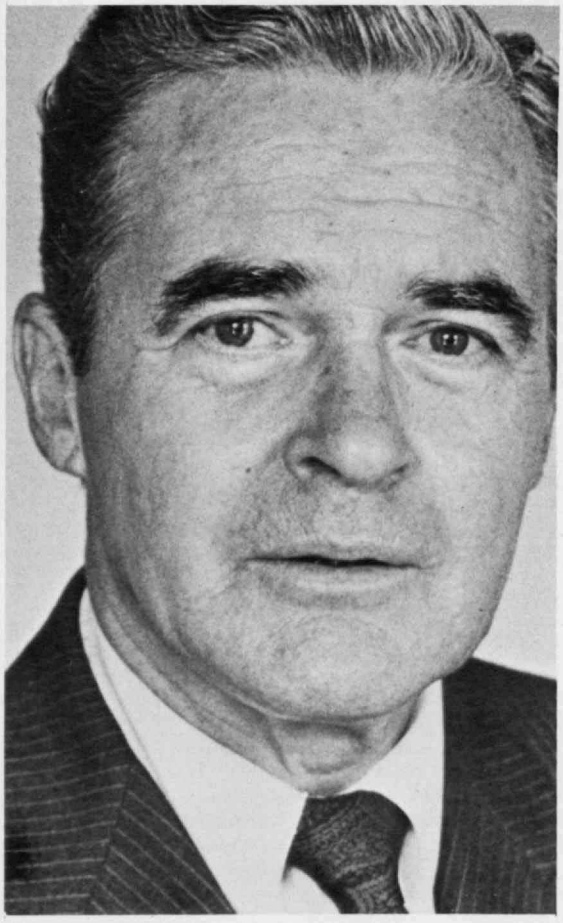
Stu Marson got married in June and went to Europe for his honeymoon. He's now at Stanford studying chemistry. . . . **Al Smith** is at Stanford's E.E. department. When we last heard from him he had broken his thumb skiing. . . . **Steve Ehrmann** (Papa Duck) and his Wellesley-wife Leslie are living in Westgate. Steve's graduating this June and wants to be a "global synthesizer" (a know-it-all). . . . As of a couple of months ago, **Peter Pathak** had been traveling in Europe since July and was thinking of going on to India and Australia. . . . **Al Solis** (Slosh) acted with the Harvard Summer School Repertory Theater last summer. He's hacking at M.I.T.'s Artificial Intelligence Lab and finishing a double major. . . . **Kevin R. O'Brien,** of Random fame, is still at the 'Tute. When asked to comment for the *Review* he just said he's still battling hard to get out. . . . **Donald Leland Estes, Jr.,** married Marie Ewing in San Antonio, Texas on January 22. . . . **Mark Lavin** "got married to Debbie (big surprise!)". He's been going out with her for five and one-half years.

Dave Brown, who entered with the Class of '69 and graduated with the Class of '71, is painting houses as a c.o. job. He's still active on the Student Center Committee and finally finished a sign project for the building that he started three years ago. . . . **Cathy Buckley** is living in Dorchester and going to M.I.T. She's in the master's program in political science. . . . **Betty Deakin Bennett,** who helped originate the *Seventy-Oner,* the Class of '71 newsletter, graduated in three years, with the Class of '70. By a strange coincidence her husband, Terry, was in the Class of '70. They're both currently doing graduate work at M.I.T. . . . **Kathy Jones** is teaching in the Peace Corps in Ghana. . . . **Nancy Wheatley** is working for the E.R.C. group at M.I.T. . . . **Diane Feldman** is at the University of Chicago. . . . **Bill Rastetter,** our old Freshman Council President, is studying chemistry at Harvard. . . . **John Newkirk** is still at M.I.T. in a double major program.

You can be Class Agent. Yes, you can write occasional letters to all your friends in the Class and the Alumni Association will duplicate and mail them for you. You get to keep in touch with M.I.T. and help raise funds that will be used for the Kent State Memorial Lecture and for the general Alumni Fund. Contact **H. J. Siegel** or Jeff Ingram, c/o the Alumni Office, E19-435, for more information. You don't have to be living in the Boston area to be Class Agent. . . . Yes, **Hal Moorman,** there are Class of '71 notes.

Please write to us and let us know what you're doing, so we can stop making up things.—**Howard Jay Siegel,** President, and **Leah H. Jamieson,** Executive Committee Member, 26 Peverell St., Apartments 1 and 2, respectively, Dorchester, Mass. 02125

I invested in 3M, Xerox and The Boston Five.



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